POWER

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COPYING A BAD EXAMPLE

Brown, the salesman, was making one of his periodic calls on Howe, the big chief The salesman, just back from a vacation, had a story of some very large fish "somewhere in Maine."

The big chief showed kindly interest. Was he not saving a story of his own? And having the last say, and being a man not without imagination, could he not surpass anything the salesman was offering?

Entered upon this pleasing scene a meek-mannered individual clothed in denim, who shuffled forward a little and stood uneasily, hat in hand, with left leg awkwardly "at rest," waiting to tell *his* story.

Brown finished. The chief laughed generously. Then his face hardened as he turned with a curt, "Well, what's the matter now?"

"Mr. Howe, the steam is down and the firemen say they can't get it up unless they can put on the spare boiler."

It is one of Howe's strict orders that the bank shall not be broken on that spare boiler without his permission.

"Who put them up to that? You? If you don't look out, I'll put the rollers under your skids. Now you get back there quick and see that the steam is up or you you will be on the bricks."

When the chief turned to Brown, anger had disappeared from look and tone. The second fish story began. It had not progressed far when in rushed an oiler, breathless—

"The safety on —— turbine kicked off and she shut herself down."

Now, no one can start that turbine except Howe—not if he knows it.

"What in —— did you do to it?"

"Nothin'."

"Don't stand there and lie to me. Go and pack your duds and get out of here."

And out into the plant went both—one to take his leave, the other to do a simple piece of work that any one of three men standing by could have done as well or better.

And Brown? He was dumbfounded. He had recommended Howe for this job, and here was the real Howe—not exactly the prince he had always seemed. Here was the "Mr. Hyde" version. Brown shook his head sadly and blew smoke rings toward the ceiling. Finally he said, half aloud: "I'll risk it. He deserves it and it may help him." He wrote a short note on a pad of paper lying on Howe's desk, then made his escape. "For," he said, "it is better to let it sink in."

When Howe returned he read this:

"A Word to the Wise"

"The army of a king of ancient times (history is not my specialty, you know, and I do not remember his name) was meeting disastrous defeat. From time to time heralds arrived from the battlefield with the bad tidings. Every herald, as he told his story, was struck dead by the king.

"During all the years since then not one man has ever risen to commend this ancient king for his deed. Yet men have emulated his example. *I* know one who is doing it now. Wake up! It is 1914."

Epilogue

This happened six years ago, in the "good old days" now passed forever, when men could be browbeaten in that manner. No one tries to "handle" men in that way now. There has been a change—in the *way*. There are still executives of all grades who blame the herald for the facts.

Illogical? Unjust? Unmanly? Yes, and more.

The only safe way is to welcome truth, no matter how unpalatable it may be.

Contributed by WILLIAM E. DIXON.

Combined Gas and Motor-Driven Pressure Booster Station

By A. E. WALDEN

An increased water consumption called for an additional supply of water delivery to the distribution system. This was accomplished by building two pressure booster stations, consisting of combination gas-engine and motor-driven centrifugal pump units of 75- and 150-hp. capacity, each with a pumping capacity of 2,000,000 gal. of water daily, at 55 ft. to 115 ft. and 231 ft. head respectively.

DURING the early summer of 1917 the demand for water on the Baltimore County Water and Electric Co.'s system in the district of Mt. Washington and Dickeyville, Ind., with a population of over 60,000 in the immediate territory—increased so rapidly, owing to wartime conditions, that it became necessary to augment the supply of water delivered to the distribution system, spread out somewhat in the shape of a fan to a distance of 25 miles from the main source of supply and the filtration plant, the total population in Baltimore County being something over 137,000.

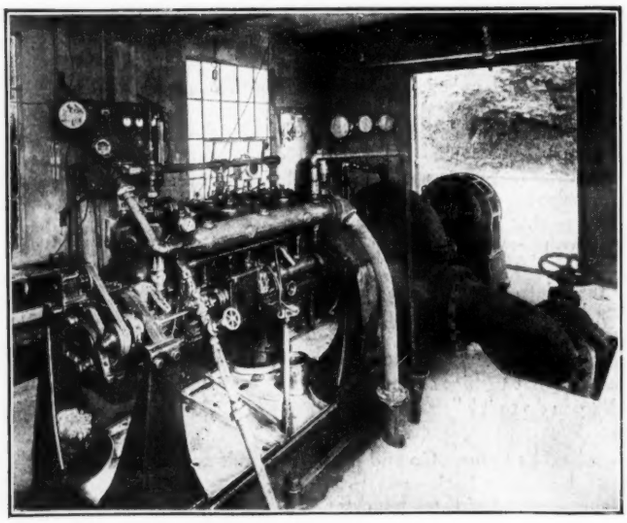

FIG. 1. INTERIOR OF MT. WASHINGTON BOOSTER STATION

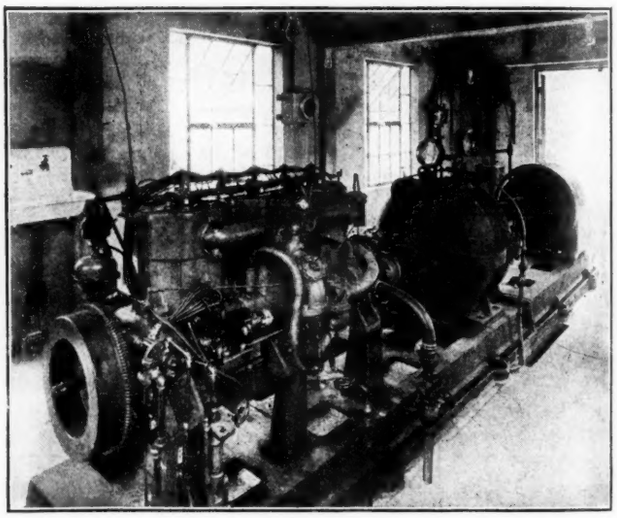

FIG. 2. INTERIOR OF DICKEYVILLE BOOSTER STATION

The source of supply of water is the Patapsco River, on which the dam, power house and filtration plant are located. The water, after being filtrated, is taken from the clear well by means of high-duty, high-head pumps, driven by turbine waterwheels or a tandem-compound steam engine or a four-stage steam-turbine-driven pump working under 712 ft. to 775 ft. head, as conditions may require, delivering the water automatically to a 4,000,000-gal. reservoir or to a 60-ft. steel standpipe having a capacity of 600,000 gal., the reservoir and base of the standpipe being between 519 and 525 ft. above sea level.

The distribution system is supplied jointly from reservoirs and standpipes some 19 miles from the first sub-pumping station, in which are located two 2-stage, 2,000,000-gal. vertical motor-driven pumps under from 130 to 150 ft. head. The pumps are directly connected to three-phase 60-cycle 220-volt 60-hp. motors, the impellers and shafts of the pumps being carried on a hydraulic thrust bearing. There is in addition a motor-driven, automatically controlled triplex pump installed in the substation, which also houses the electric meters, transformers, switching equipment and a water meter for recording the total water delivered to the system in this district.

The floor of this substation has an elevation of 519 ft. above sea level or datum, from which the elevations vary down to 93 ft. above datum, increasing again to from 500 ft. to 560 ft. above datum, these being the reservoir and standpipe elevations respectively, at a distance from the repumping station as already given, and from which the water is distributed to other sections between and beyond the four sub-pumping stations and reservoirs, the pressures on the intervening main line being from 60 to 200 lb. per square inch.

Not only was it impossible to obtain deliveries of cast-iron pipe at this time, but quotations were $75 per ton, or three times the normal price. Furthermore, the cost of laying the pipe was excessive and labor was hard to obtain.

It was evident that some less costly method of increasing the supply of water must be resorted to until normal conditions were restored. The present pipe line, when originally installed, was tested to 300 lb. per sq.in., and after some consideration the company's engineers, Wehr and Walden, decided to install one or more booster pumps. To this end a design was worked out combining on one bedplate a multiple-cylinder gasoline engine, an electric motor and a turbine pumping unit.

The first unit, installed at Mt. Washington in July, 1918, consisted of a 75- to 80-hp., six-cylinder gasoline engine of the automobile type, running at 1,200 r.p.m., equipped with a two-unit 24-volt electric starting motor and charging generator similar to the standard automobile equipment, but the engine was provided with additional equipment, such as automatic speed control, a vacuum system for fuel feed from a 250-gal. storage tank, electric speed indicators, recording thermometers for the cooling water, oil-pressure gages, a mercury U-gage connected to the intake manifold, etc. The engine is automatically oiled by a rotary pump located in the base and driven by the main engine from the layshaft, the oil pressure on the bearings being maintained at 20 lb. per sq.in. The hot oil is also circulated in a jacket around the intake manifold, heating it and at the same time reducing the temperature of the oil somewhat.

This unit is connected through a flexible coupling to a single-stage pump to operate at 1,200 r.p.m. and deliver 2,000,000 gal. daily at two different heads, 55 and 115 ft.; the pump, in turn, is again connected at the other end, through a flexible coupling, to the shaft of a 50-hp. 220-volt three-phase motor, to provide against possible breakdowns of the engine unit. This unit is self-contained.

The starting current for the 24-volt starting motor and station lighting is supplied from a 24-volt 150-ampere-hour storage battery which, while the engine is in operation, is being charged continuously.

Figs. 1 and 2 show the Mt. Washington and the Dickeyville booster-station equipment and Fig. 4, one of the outdoor electric substations, transformers, high-tension lightning arresters and switching equipment. The flow area of this station is 300 sq.ft. This engine has been in continuous and successful operation from the time it was started.

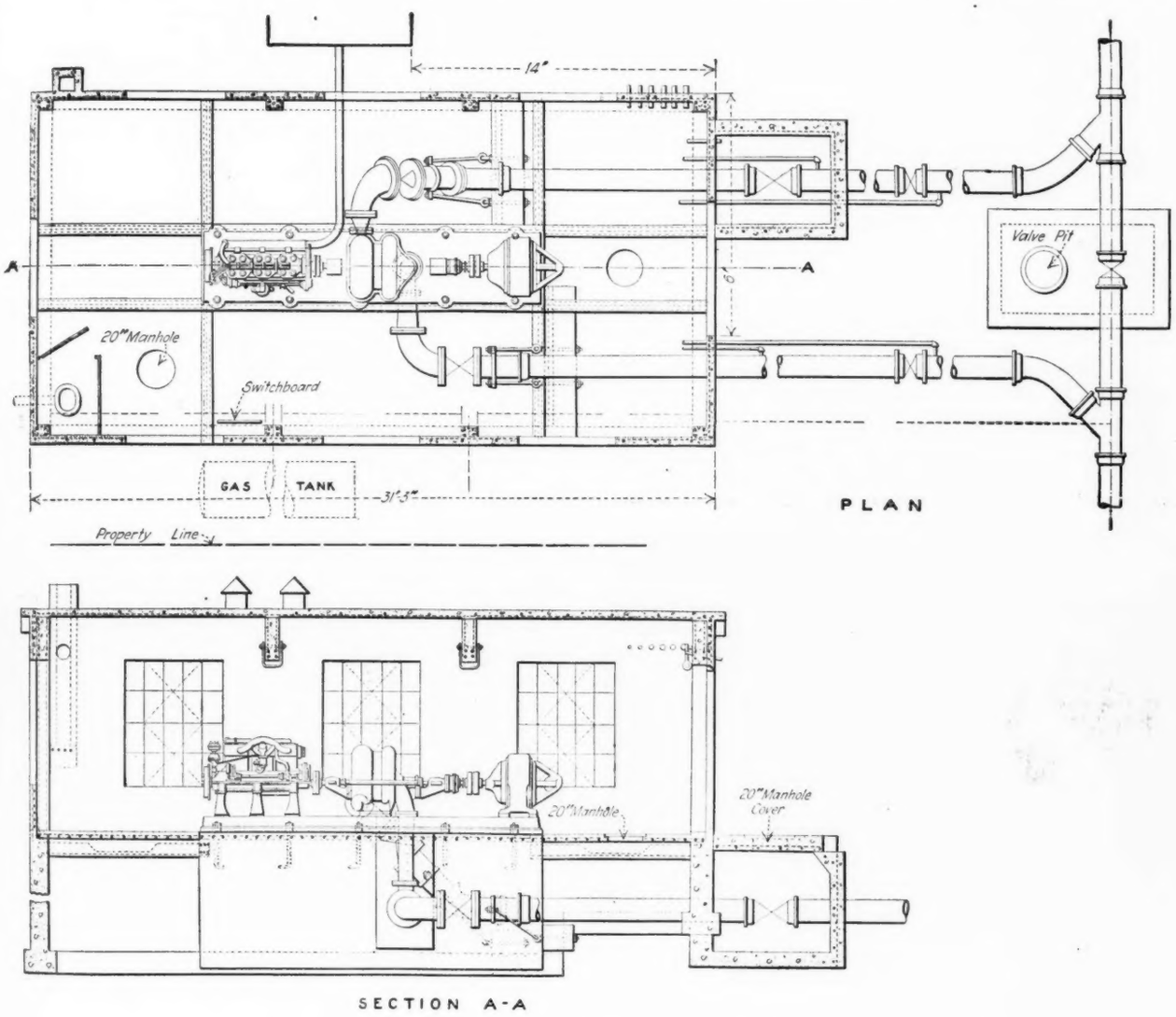

FIG. 3. PLAN AND ELEVATION SHOWING GENERAL ARRANGEMENT OF PUMPING PLANT

The Dickeyville station was not completed until July, 1919, on account of the inability to obtain the engine and pumping equipment. This station has a floor area of 450 sq.ft. and contains a six-cylinder 150-hp. marine gasoline engine running at 1,200 r.p.m., Fig. 2. It is equipped with speed control, triple ignition system, electric speed indicator, gasoline pumps, recording thermometers, two-unit 24-volt automatic starting motor and charging generator, and 24-volt 150-ampere-hour storage batteries, recording and indicating pressure gages and a U-shaped mercury column connected to the

intake manifold, which indicates at all times the condition of the valves and the operation of the engine.

The fuel for this unit is taken from a 500-gal. storage tank by a rotary pump driven by the layshaft on the main engine. The fuel is delivered to an elevated tank in the building, equipped with a sight gage and overflow to the main tank.

The forced-feed oiling system is supplied by a pump, driven from the layshaft, and is located at the base of the engine, which maintains the oil pressure on the bearings at 10 lb. or more per square inch.

This unit is connected, through a flexible coupling, to a two-stage turbine pump and delivers 2,000,000 gal. daily under a 231-ft. head; it is equipped with a hydraulic balancing device to balance the thrust. The pump is also connected at the other end to a 100-hp. 60-cycle three-phase motor, to insure continuity of service; the motor under ordinary conditions of operation is idle. The general arrangement and plant layout are shown in Fig. 3.

These installations have so far operated satisfactorily, except for some shaft trouble, due to too light construction for continuous duty of the 150-hp. unit, and also carburetor troubles. Some types of carburetors do not give the same results and efficiencies as others, but the operating conditions are more easily checked from the indications given by the difference in the levels of the legs of the mercury column, which varies from 4½ to 9½ in. This is an indication of both the operating condition of the engine and the load.

It was found that the oil pressure on the bearings should not go below 10 lb. per sq.in. for the best

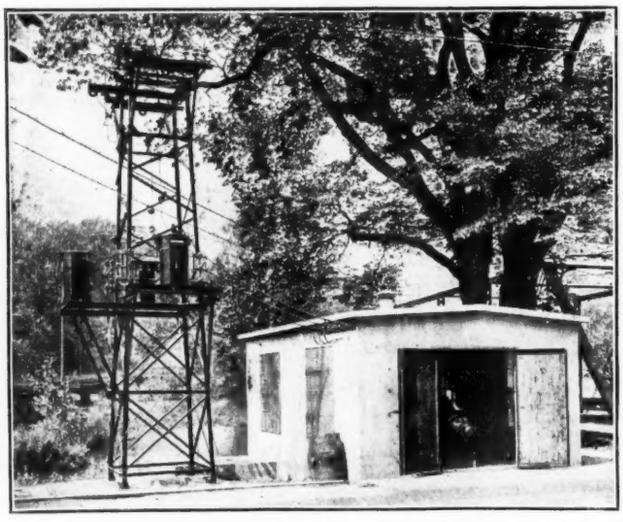

FIG. 4. OUTDOOR SUBSTATION AND BOOSTER STATION

results, and preferably 20 lb., using what is known as No. 4 gas-engine oil for lubricating purposes.

The operating troubles in these plants have been mostly due to dirt in the strainers, poor contact of brushes in the magnetos and generator brushes. To care for this promptly, duplicate magnetos and spare parts should be kept on hand.

A slight amount of water is introduced into the intake by means of the suction or difference of pressure between the atmosphere and that in the intake, and mixed with the air and gas. The water is contained in a small tank mounted slightly above the engine and connected by a 1-in. pipe to the intake manifold. The carburetors that have given the best results in operation seem to be those in which the air velocity and vaporization of the gas are such as to cause considerable sweat on the outside of the carburetor, due to difference in temperature, but these should have a reasonable adjustment of the float-feed valve to care for the variations in oil, and are preferably equipped for

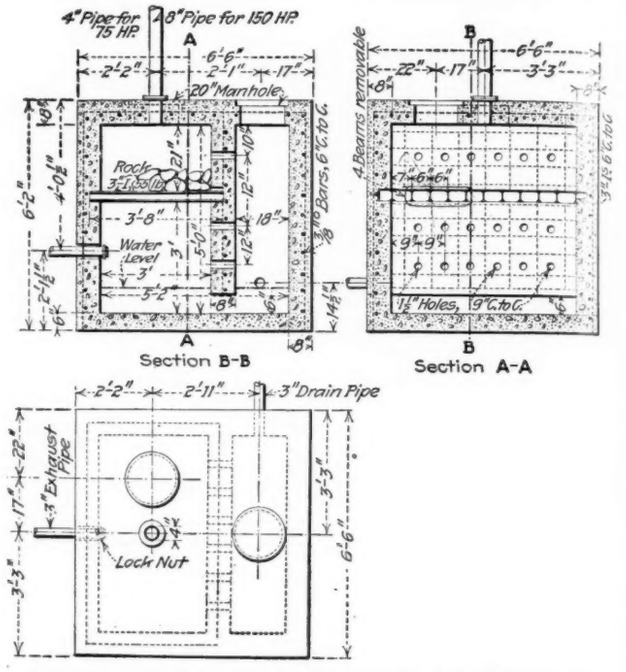

FIG. 5. DETAILS OF MUFFLER-PIT CONSTRUCTION

heating by means of a small amount of hot water from the jackets or in some other suitable manner.

The muffler pits, shown in Fig 5, have worked perfectly, there being very little noise, no smoke, but a little vapor from the water which is injected into the exhaust manifold to cool it and prevent backfiring in the pit; and the water injected into the intake manifold which is to a certain extent a further preventive of the burning of the exhaust-valve stems.

The dimensions of the pits as shown are ample for engines up to 150 hp., so that there will be no objection to the operation of these units in residence districts or where there are restrictions as to noise, etc.

There are always two batteries in service, one full and one under charge, so as to assure one full battery for turning over the engine in case of any trouble.

The 150- and the 75-hp. engines require one barrel of oil per month each, and it seems that if a cooling tank could be connected to the pans under the base, this system would materially reduce the expense for oil on these engines.

In selecting gas engines for power purposes, if the engine has a rating of 150 hp., every effort should be made to see that it develops that horsepower at the speed, or slightly above the speed, at which it is desired to operate the unit. With the rating reduced, in the case of a six-cylinder engine, by two cylinders, the maximum load of this engine, in so far as the purchaser is concerned, would be 100 brake horsepower. In other words, the 150-hp. unit would be rated to deliver its brake horsepower at 25 hp. per cylinder.

The unit to be driven should have its horsepower requirements accurately determined by an electric dynamometer and contract provisions should be made accordingly.

Vertical-Shaft Waterwheel-Driven Alternators—Brakes, Ventilation and Exciters

Brakes Operated by Hand and Compressed Air, Ventilation of Alternators and Excitation with Direct-Connected and Independent Exciters

By S. H. MORTENSEN
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WITH the larger types of water-driven alternators brakes are generally furnished. They are required to bring the unit to a standstill and to keep it at rest in case leaky turbine gates allow a sufficient amount of water to pass through the wheel to keep it in motion. Brakes are also of great value in case of accidents, when it becomes of the greatest importance to stop the unit in the shortest possible time.

On vertical machines the brake shoes rub against the finished surface of the spider rim. The brake shoes may be made of wood or asbestos wood, and the braking power may be supplied from a piston actuated by either compressed air or oil or by a system of levers, hand operated. The brake arrangement, Fig. 1, is for hand

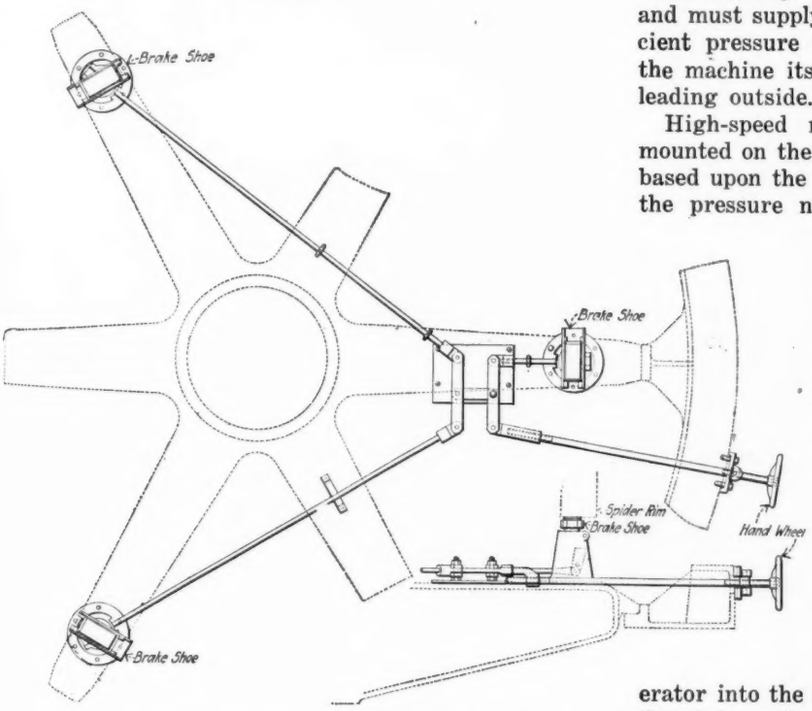


FIG. 1. A FORM OF BRAKE ARRANGEMENT FOR OPERATION BY HAND

operation, and Fig. 2 shows the brake shoe and brake cylinder designed for compressed-air manipulation. Brakes are designed so they will bring the unit to standstill in from three to five minutes, with a gate leakage of approximately 3 per cent.

Ventilation of small vertical alternators is simple. The radiating surfaces, combined with the draft set up by the field rotation, generally is sufficient to dissipate the heat generated by the various losses in the machine. On the medium-sized machines ventilating vanes mounted upon the rotor spider are relied upon to stir the air and create a sufficient draft to keep the machine cool. The ventilating air is usually taken from the top and bottom of the rotor and is exhausted through the stator yoke into the station.

Slow-speed machines of large capacity generally operate at too low peripheral velocity to produce sufficient air pressure for their proper ventilation, which then must be supplied by independent fans or blowers. Such installations are necessarily more elaborate and require air ducts leading to and from the machine. The intake duct or tunnel should be arranged to take the air from over the tailrace. This insures cool, clean ventilating air that does not require any further filtering or washing, and it is necessary to provide only a coarse screen in the air tunnel to prevent large objects from entering. The blowers are generally motor driven, and must supply the required volume of air at a sufficient pressure to force it through the intake ducts, the machine itself and exhaust it through the tunnels leading outside.

High-speed machines are self-ventilated by fans mounted on the field spider. The design of the fans is based upon the amount of air they have to deliver and the pressure necessary to force this amount of air through the ducts and the machine. In Fig. 1 of the previous article was shown a self-ventilating alternator. The top of the machine is totally inclosed, and the ventilating air is obtained from air ducts leading to the pit under the alternator. After it passes through the fans, part of it sweeps over the coil ends and out through openings in the yoke. The remainder, after cooling the field coils, is forced over the inner stator-core surface, through the ventilating openings in the stator core, and escapes finally through holes in the stator yoke. In installations where it is undesirable to have heated air escape from the generator into the station, an inclosure is provided around the stator yoke. This arrangement not only leads the air outside of the station, but also greatly reduces the magnetic and windage noises that are inherent in high-speed operation. Sometimes doors are provided in the air-exhaust ducts, which permit the admission of hot air to the station when desirable for heating purposes.

The amount of air required per kilowatt loss in an alternator depends upon the air temperature. Where the ventilating-air temperature is from 15 to 25 deg. C. (69 to 77 deg. F.), from 100 to 115 cu.ft. per minute per kilowatt loss should be supplied. If the air temperatures are from 25 to 40 deg. C. (77 to 104 deg. F.), the volume of air that should be supplied will range from 115 to 135 cu.ft. per minute for each. The kilowatt loss air velocity through the ducts should not exceed from

200 to 300 ft. per minute for self-ventilated slow-speed machines. For high-speed or separately ventilated units velocities up to 1,000 or 1,200 ft. per minute are permissible. This leads to large air ducts and makes it necessary to give due consideration to their proper location and dimensions at the time the buildings for the power stations are designed. As an example, if the ducts leading to the alternator should be proportioned for 80,000 cu.ft. of air per minute, allowing an air

FIG. 2. COMPRESSED-AIR OPERATED BRAKE

velocity of 1,000 ft. per minute would then necessitate a duct section of 80 sq.ft. The ducts should be as short as practicable and also be without bends or abrupt turns, and both the intake and exhaust openings should be protected against wind pressure, flood water, etc.

In addition to checking the temperatures of the generator proper, it is advisable to check the temperature of the ventilating air. If the temperature increase exceeds 18 to 22 deg. C. (32.4 to 39.6 deg. F.), it is an indication that the amount supplied is not sufficient, and arrangements should be made to increase the volume of the ventilating air.

For an alternating-current installation the choice of the excitation system is necessarily of great importance and should be given careful consideration. It must be reliable, flexible, efficient, have ample spare capacity and at the same time represent the minimum investment compatible with the requirements mentioned.

Small slow-speed alternators require comparatively large-capacity exciters, which, if run at the alternator speed, would be expensive and have a low efficiency. To overcome this handicap, this class of machine is generally supplied with high-speed exciters geared or belt driven from the alternator shaft. Spare capacity should be provided either as extra parts for the exciter proper or as separately driven exciter units.

In large-capacity stations or in stations with high-speed units the exciters are either direct connected to the main unit, as in Fig. 3, or driven by separate waterwheels.

The direct-connected exciter is mounted on the top bearing housing of the alternator and its armature upon an extension of the mainshaft. The exciter capacity is made sufficient for one alternator except in stations where only two units are installed. In such installations spare capacity is obtained by using exciters with sufficient capacity for both units. The exciters may operate in parallel, but are more frequently wired directly to the alternator. They should, however, have taps for connecting them to a transfer bus, thereby making it feasible to operate any alternator in conjunction with any exciter in the station.

In a station with direct-connected exciters it is customary to supply a motor-generator set as a spare unit. The motor may be either of the synchronous or the induction type, and the exciter capacity should be sufficient to take care of one alternator. In stations where a great many units are in operation, it is advisable to provide two such spare sets.

Installations with the waterwheel-driven exciters generally have two duplicate units, each with sufficient capacity to carry the total station load. In addition they should have sufficient excess capacity to provide power for operating the station auxiliaries.

The separately driven exciter, as compared to the directly connected type, has an advantage in small- and medium-capacity installations. However, in large or high-speed installations the use of directly connected exciters is advantageous.

Either type of installation requires a main field rheostat with sufficient capacity to take care of all the operating conditions that may occur. This means that in stations with separately driven exciters, the current-carrying capacity and resistance must be proportioned to meet the requirements based upon full excitation voltage, which leads to large and expensive rheostats. With the direct-connected exciters it is practical to alter the exciter voltage within certain limits by means of an exciter rheostat and thereby materially reduce the operating range required from the main field rheostat. This substantially lessens the rheostat cost and reduces the

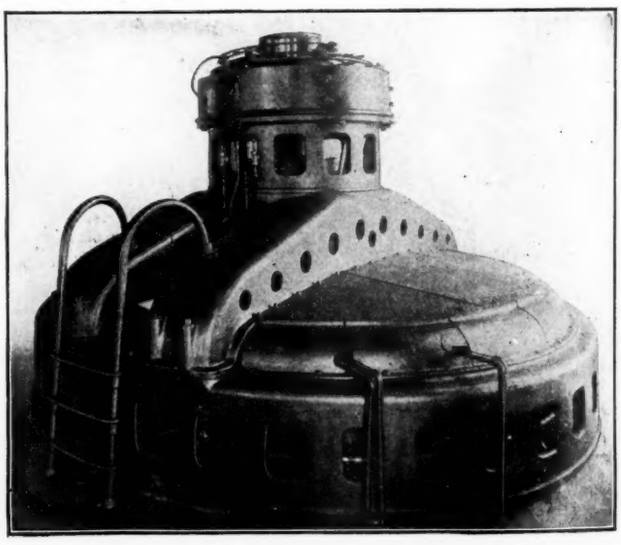


FIG. 3. EXCITER MOUNTED ON TOP BEARING HOUSING

waste of energy in the rheostat resistance, thus increasing the operating efficiency. An exception to the rule that rheostats are required, is to be found in stations operating under constant-load, voltage and power-factor conditions. For such installations successful operation may be obtained without the use of a main field rheostat.

In conclusion attention is called to the danger to which a station with direct-connected exciters is subjected when a unit runs away and the cumulative effect of the increase in the frequency and also in the exciter voltage results in an over-voltage much in excess of the normal value. This condition may be guarded against in different ways—as an example, by means of specially designed automatic voltage regulators or by some speed-limiting device acting upon the turbine gates.

Testing for Ammonia Leaks in Refrigerating Plants

Gives Some Simple Directions for Testing for Ammonia Leaks witl Phenolphthalein and Sulphur Sticks

By B. E. HILL
Field Refrigerating Engineer with Swift & Company

TESTING for ammonia leaks is an important part of an engineer's duty. There are two principal places to test, one being in a submerged tank, where, if there is a leak in the coils, water cooler or any liquid, the ammonia will be absorbed. If the liquid is of great volume there will be a considerable quantity of ammonia taken up before the engineer or attendant can detect the odor.

To test the brine or other liquid for a leak, send to the drug store for an ounce or two of phenolphthalein; then get a sample of brine in a glass bottle or drinking glass and put a drop or two of the phenolphthalein into the brine. If there is the least trace of ammonia, even so small that it cannot be detected by smell, the phenolphthalein will cause the brine sample to turn a faint pink, and if there is enough ammonia to detect slightly by smell, the sample will turn a deep red.

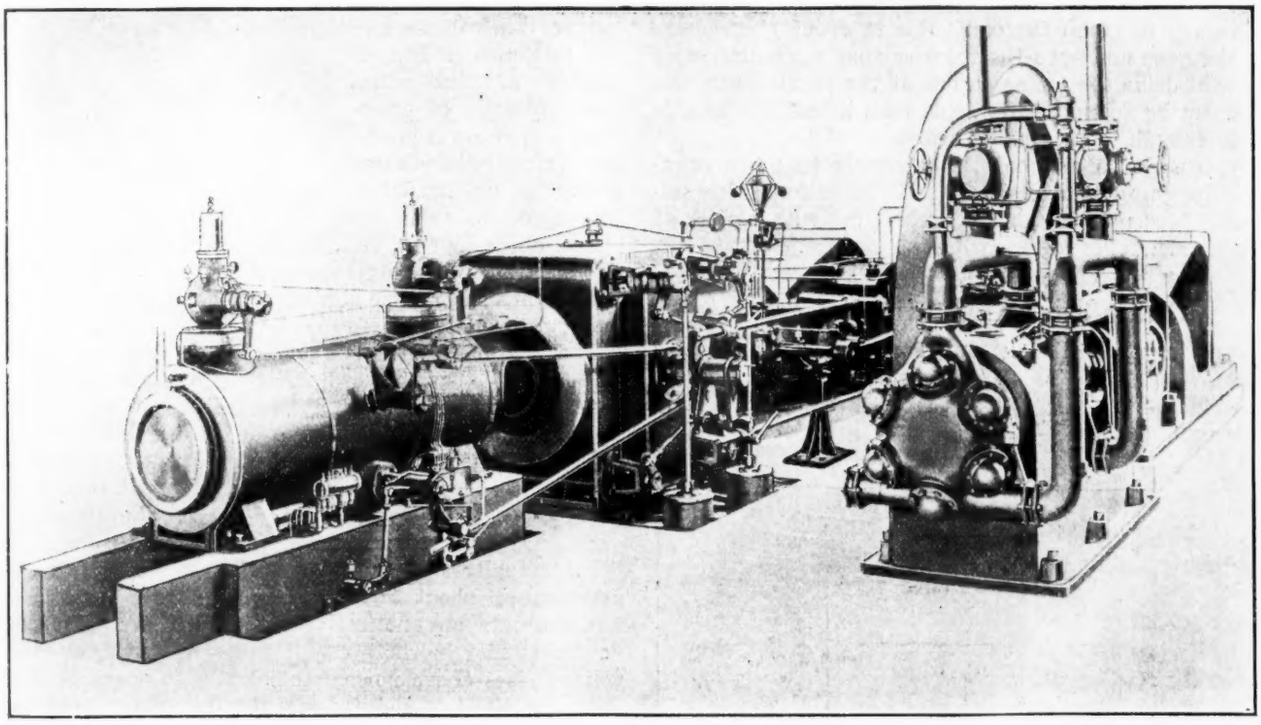
If desired to determine how much anhydrous ammonia has leaked out into the brine or other liquid, take a sample of the brine to a good chemist and give him the total volume of the liquid; he will make the necessary calculations for ascertaining the total leakage.

The next test is for leaks in the open air, and as the sulphur stick is the most popular, effective and practical, we will consider where it can be used and where not.

To prepare the sulphur stick melt five or ten pounds of either powdered or lump sulphur in a ladle with a very slow fire. A slow fire is necessary as the sulphur fires at a low temperature and, if too hot, will become lumpy and thick and will run off and drip when used. When the sulphur is at the right temperature it will be thin like water. Now the sticks should be prepared by splitting up a hundred or so pine strips, cardboard or other material and dipping both ends in the sulphur, which quickly cools; the sticks are now ready for use. To apply the sticks, take a handful and light one, and before one burns out another can be lighted from the one in use.

Any coil that has just been erected or overhauled should first be tested with air pressure, after which the joints should be brushed with soapy water. After all leaks found in this way have been stopped, pump out the air until the vacuum gage shows as high a vacuum as can be had. If it is found that the air is still discharging through the discharge bypass, keep on pumping till the air is hardly perceptible. This extra precaution is taken to make sure that the air is as nearly all out as can be pumped with the machine; also, there is always a chance that the vacuum gage may not be correct.

After the air has been pumped out the ammonia should be charged into the coil at once and the final test made with the burning sulphur held under and over all joints and connections. If there is a leak at all, it will be shown by a gray smoke wherever the sulphur and



A LARGE AMMONIA COMPRESSOR DRIVEN BY A COMPOUND UNIFLOW-CORLISS ENGINE

ammonia fumes come together. The sulphur fumes are as effective in showing a leak in the open air as the phenolphthalein is for showing one in the brine tank; as, for example, where there is a leak in a thread or joint that is so small that it will not be noticed with the soap bubbles and is difficult to detect by smell after the leak is found, the sulphur will mark the leak by leaving a small yellowish white spot, even though the leak is no larger than a pin point.

Leaks on return bends of atmospheric condensers, where the condensing water is flowing over the part that is leaking, will cause the solids in the water to accumulate to a considerable extent, which deposit will be of a whitish color. Leaks in water jackets on the compressor, if of any extent, will clarify the water, and if the fingers are dipped in it and rubbed together they will feel soapy. In this case the leak can easily be detected by smell.

In a room where the timbers or building materials of any kind are damp from moisture, the sulphur stick is almost useless, as the moisture will take up the ammonia gas and the sulphur will sometimes "smoke up" the whole room and show smoke on a post or the wall where there is no leak. In such cases it is sometimes necessary to pump the coil down to about atmosphere on the gage and open the room so that a circulation of air will drive the ammonia out of the room before the leak can be found. This holds true unless the leak is large enough to be seen or heard.

A crusade on ammonia leaks should be made regularly by going over all joints and connections with sulphur sticks, marking the leaks as found with a piece of chalk, then following up with the repairs.

Oxide-Film Lightning Arrester

As a result of the demand for a lightning arrester that would give the same amount of protection as the aluminum arrester without the necessity of daily charging, the oxide-film lightning arrester has been

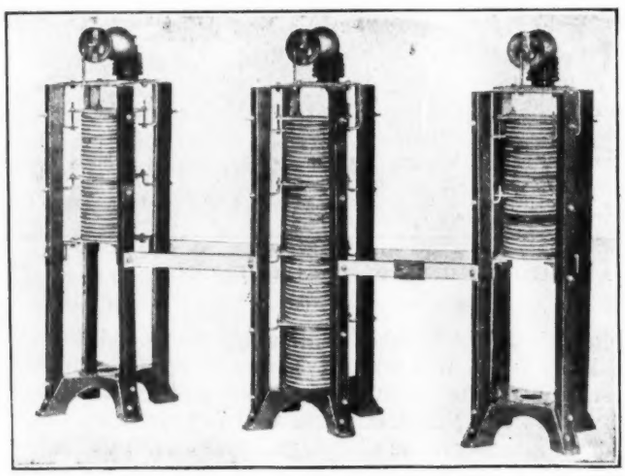


FIG. 1. LIGHTNING ARRESTERS FOR INDOOR SERVICE ON THREE-PHASE CIRCUIT

developed. This charging consists in connecting the aluminum arrester to the line for a short period each day, in order to renew the non-conducting film on the plates, and has made this arrester impractical of installation in isolated places. The oxide-film arrester does not require daily attendance to insure the maintenance of its protective qualities. Therefore, although it is practical for almost any application, its principal field seems to be where daily attention is not available but where good protection is required. Lately, there has been a large increase in the number of isolated stations and substations where the class of service calls for highly reliable protection, and it is here that the oxide-film arrester finds its greatest field of usefulness. The construction of the arrester is very simple, requiring no oil or electrolyte. It consists of a stack of cells connected to a sphere gap, Fig. 1. In the outside type these cells and sphere gaps are thoroughly protected from the weather, which insures a uniform spark potential under all climatic conditions. The cells, one of which, developed by the General Electric Co., is shown in Fig. 2, consist of two thin steel plates, or electrodes, spun on a porcelain ring, the latter acting as an insulator. The space between the plates, about half an inch, is filled with lead peroxide. The electrodes are further provided with an insulating film of varnish or some similar compound which gives a uniform insulated surface.

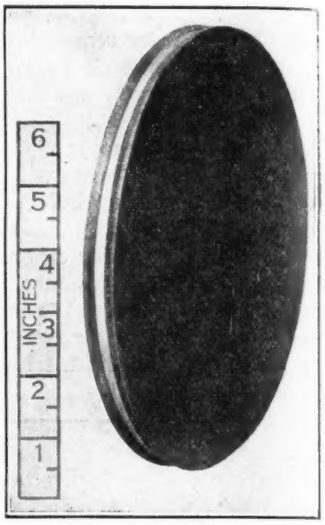


FIG. 2. OXIDE-FILM LIGHTNING-ARRESTER CELL

The operating principle depends on the fact that lead peroxide, which ordinarily is of low electrical resistance, is unstable at a temperature of about 250 deg. C. and forms a lower oxide, called litharge, of high resistance to electric current. Thus, although its action is thermal instead of electrolytic, it functions in a good deal the same way as an aluminum-cell arrester, by preventing the flow of dynamic current. What actually happens in practice is that up to a pressure of about 300 volts per cell the insulating film prevents any noticeable amount of current from flowing under normal conditions. As soon as the voltage rises above normal sufficiently to spark on the gaps, the film is punctured and the lightning discharge flows to ground, since it meets very little resistance. When the dynamic current attempts to follow, the smallness of the punctures causes great concentration of current at those points, with a consequent localized heating which is enough to cause the lead peroxide to break down, forming litharge, in the path of the current, thus effectually blocking it. The film reseals itself in about one four-thousandth of a second after the excess lightning voltage has ceased. Since the powder is a poor heat conductor, the formation of these high-resistance plugs is confined to the actual area surrounding the puncture.

As this action is due to the inherent chemical property of the material between the electrodes, and it is this material which forms and reforms the insulating film, there is no action similar to the gradual dissolving of the film as in there is the aluminum arrester.

Efficient Operation of the Boiler Plant

By JOHN D. MORGAN

Various types of stokers are treated, as regards requirements of design, also the effect of boiler feed-water temperature. Plant labor is considered and data and curves are presented that have a direct bearing on boiler-room maintenance, together with suitable plant-record sheets.

HAND-FIRED furnaces are rapidly becoming obsolete, but when so fired the use of some type of rocking grate is the best practice. Although the loss of coal through the grates is slightly more than that of the flat grates, this loss does not affect the efficiency enough to be considered.

A suitable arch should be designed which will properly mix the air and gases. The firing should be done

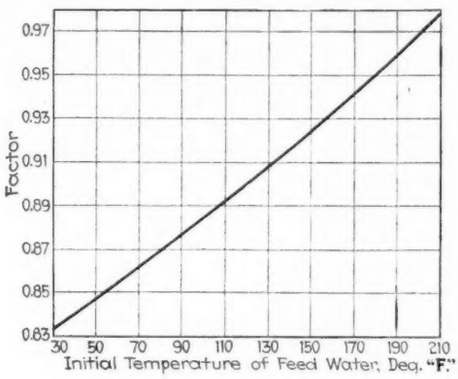


FIG. 1. FACTOR CURVE FOR PER CENT SAVING FOR INCREASED FEED-WATER TEMPERATURE

alternately in narrow strips across the full length of the grate, and when this method is used it is advisable to fire light and often and keep the doors cracked. The boiler should be equipped with a reliable draft gage, and the draft should be kept at a predetermined point by means of the damper and the fire thickness.

Three Classes of Stoker Firing

Stoker firing can be divided into three classes, namely: Front-feed and inclined-grate type, chain-grate, and underfeed stoker. In considering the inclined-grate type of stokers, the most important operating points of this type are the proper training of the men operating them, constant attention to avoid holes in the fire, proper feed and grate motion; and if an intensified combustion is desired, an air space should be made in front of the ignition arch. Here again, the design of the arch and bridge wall is of vital importance to proper operation. The total amount of steam used by auxiliaries for this type of stoker does not as a rule exceed 2 per cent of the total steam generated. This point should be given due weight in comparing it with other types.

The chain-grate type is in common usage in many parts of the country. The kind or nature of the coal available plays an important part in the performance of the stoker. The general items that will affect its economic operation are: Draft carried; speed of the grate; character of ignition arch; thickness of the fire and the size of coal.

Some of the advantages of the underfeed stoker are: Compactness; small combustion space; complete mixing of air and gases; gases are intensely heated by rising through incandescent coal; absence of ashes; small size of stack; complete ash fusion and the obtainability of high ratings. The only real drawback is that of cleaning the fire after a forced run of a few hours' duration.

If an underfeed stoker is to be operated in an economical way, it should have the following features: An adjustable, continuous and automatic dump by means of an adjustable opening adjacent to the bridge

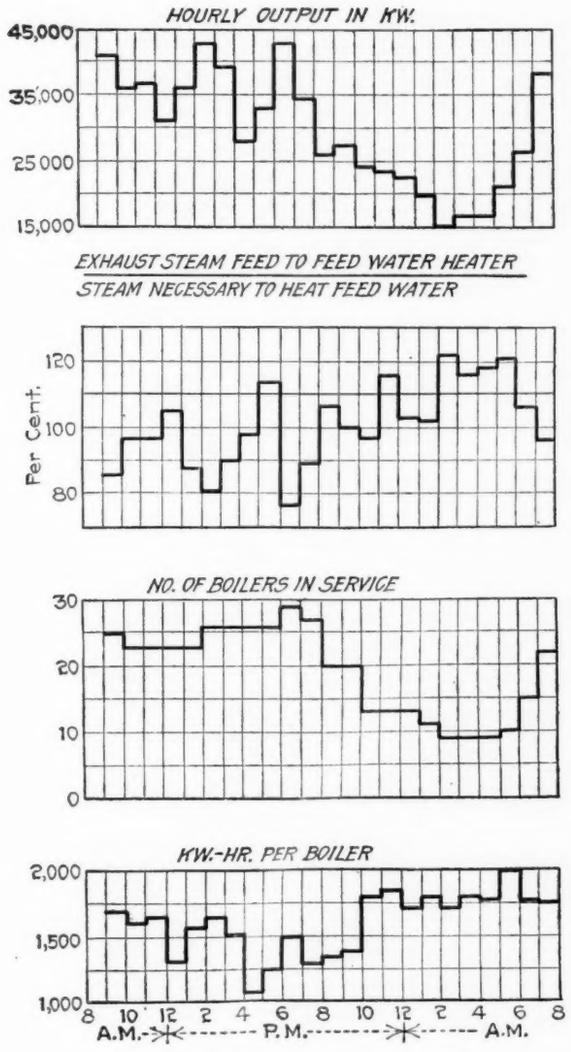


FIG. 2. FEED-WATER HEATER TEST

wall. This dump should be provided with an indicator. The air-supplying grates should reciprocate sufficiently to agitate and move the fuel bed uniformly to the dump. Each plunger connection should have a safety device

so that the plunger may be blocked at any point in the stroke without injury to the stoker. It should be equipped with an overfeed grate for final combustion and a variable-speed engine or motor for driving the stoker shafting.

Furthermore, there should be an instrument panel upon which should be mounted a recording temperature gage for feed-water-inlet temperature, a recording temperature gage for the temperature of steam, a pen-

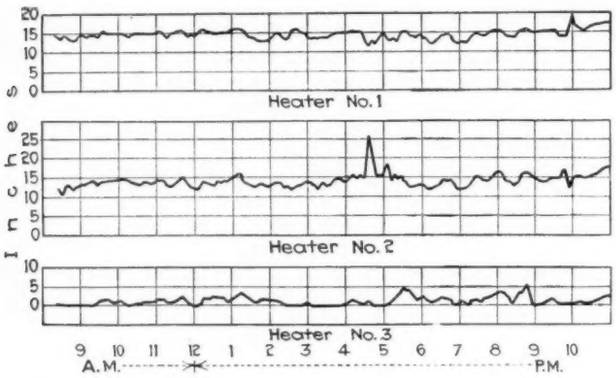


FIG. 3. HEIGHT OF WATER IN FEED-WATER HEATER GAGE GLASS IN INCHES

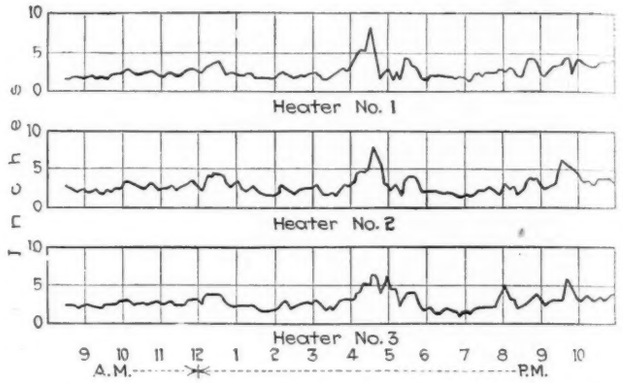


FIG. 4. PRESSURE OF EXHAUST STEAM IN HEATER, INCHES OF MERCURY

recording pressure gage for recording the air pressure beneath the fire, an electric tachometer for indicating the speed of stoker shafting, etc., two differential draft gages for indicating draft or pressure over the fire and at the damper, and a direct-reading U-tube gage for indicating the air pressure in the main duct.

The first point in regard to the method of operation is to run a series of tests to determine the effect of various speeds and draft pressures on the efficiency of the stoker. After this has been done a table should be made up, which will show the following items for all various boiler ratings: Boiler rating per cent; speed of stoker drive; air pressure under fire; draft over fire;

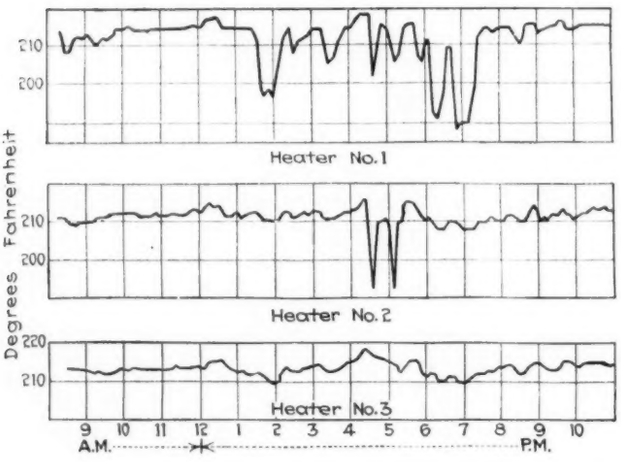


FIG. 5. TEMPERATURE OF FEED-WATER FROM HEATER, DEGREES F.

draft at boiler damper; thickness of fire, pounds of coal per hour; pounds of steam per hour; efficiency.

With the aid of such a table a boiler can be run in an efficient manner, but it must be remembered that at 300 per cent rating the drop in efficiency from that at 100 per cent will be about 12 per cent, and as a rule the best continuous working point will be found to be about 150 per cent rating. There is one point in the operation of this type of stoker over which engineers disagree, and that is the draft or pressure to be carried over the fire. I favor carrying a draft of 0.02 in. over the fire at 100 per cent rating and varying it gradually upward with the increase of boiler rating so that when 300 per cent rating is reached there will be a draft of 0.1 in. over the fire. These recommendations are based on the results of many boiler tests and on the final maintenance figures.

Regarding boiler-feed-water temperatures the question arises as to how much increased feed-water temperature helps. The curve shown in Fig. 1 shows the percentage of saving for each degree of increase for varying initial temperatures.

Since it has been shown that each and every degree of increase in feed-water temperature pays, the first procedure should be the making of a 24-hour test to determine the exact feed-water-temperature condition of the plant. An example of what such a test consists of is given in Figs. 2, 3, 4 and 5.

For many plants it will be found that unsatisfactory temperature conditions prevail, no doubt due to many causes, but as a rule these causes or conditions may be traced to the following items: Insufficient exhaust steam to heat the feed water; dirty feed-water heaters; irregular feeding of water into the boilers; surging and overflowing of the open feed-water heater; faulty operation of the float regulating valve on the heater and poor pressure regulation of feed-water pumps.

Insufficient Exhaust Steam

Insufficient exhaust steam for heating feed water is largely a question of plant design and can be attended to only by the installation of an economizer or a heat-balance valve. The installation of a heat-balance valve is a simple and inexpensive way of overcoming this condition. The working operation of such a valve simply consists in keeping the pressure in the exhaust main at a predetermined point by bleeding to or from the secondary stages of the turbines.

It is becoming the practice in all new plants to install economizers. This has largely been brought about by the use of motor-driven auxiliaries, on account of the increase in efficiency over steam-driven auxiliaries, and also by the use of stokers capable of high ratings, because at high ratings the temperature of the flue gas

is sufficient to warrant the installation of an economizer. In considering an economizer, the first and most important point is that of the direction of water flow. Undoubtedly, this item has an effect on the efficiency of the economizer. The following plan is practically ideal: Suppose the economizer is composed of 40 rows of tubes with 12 tubes per row. For water-flow purposes it should be divided into three groups, one of 16 and two of 12 rows of tubes each. The circulation should be in series for the three groups. The circulation in the first group would be divided as follows: Up the first eight, down the next four and up the last four tubes; in the second and third groups the water should flow up the first four, down the second four and up the last four tubes. With such a circulation the drop in pressure will not exceed 25 to 30 lb. The second item to be considered is that of air leaks. There should be a total absence of air leaks if high efficiency is to be obtained. The curves in Figs. 6, 7 and 8 show the operation of an economizer.

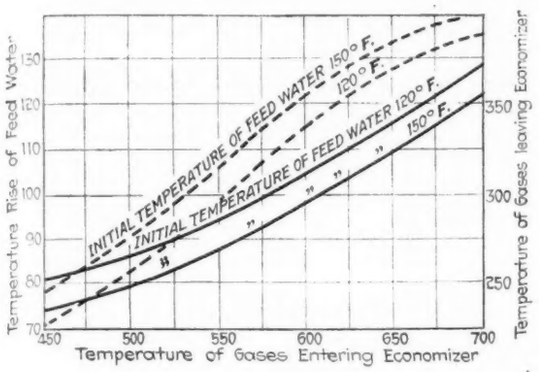

Temperature Rise of Feed Water
Temperature of Gases leaving Economizer
INITIAL TEMPERATURE OF FEED WATER 150° F.
120° F.
INITIAL TEMPERATURE OF FEED WATER 120° F.
150° F.
Temperature of Gases Entering Economizer

FIG. 6. ECONOMIZER PERFORMANCE CURVES

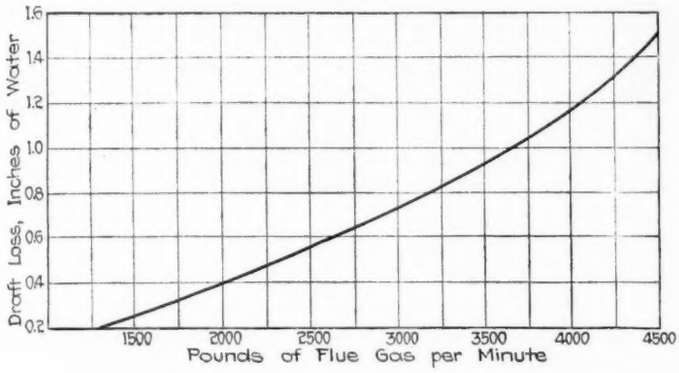


FIG. 7. ECONOMIZER PERFORMANCE CURVE

Dirty feed-water heaters are a source of serious loss, and it is advisable to inspect them and clean them at least once every month.

Irregular Water Feeding

Irregular feeding of water into the boilers can be corrected by the installation of feed-water regulators and the maintaining of an even pump-discharge pressure. And even where the boilers are hand-regulated, it is possible to maintain an even feed by drilling the water tender to study his fire conditions.

Often a serious loss results from the overflowing of the open heater. This is caused by improper feeding and a lack of regulation of the steam supply. This trouble can frequently be overcome if a seal is placed on the overflow line, constructed in the form of a V-tube or return-bend coil, and it can be designed to maintain any predetermined pressure in the heater. This will tend to do away with the surging.

The faulty operation of the float-regulating valve is also due to the improper design of the operating levers or to the float being located near to the heater outlet, so that the float gives a faulty reading due to a suction in and around the outlet pipe.

Maintaining a steady feed-water pressure is simple if a good pressure-regulating valve is put on each pump. Care should be exercised in the piping up of such a valve. For instance, the water inlet should never be tapped into the feed line at a point near the pump discharge, but rather it should have an auxiliary line of its own from some point in the main boiler-feed line.

Another plant loss, the blowoff loss, is a variable and depends largely on the valve leakage and the number of times the boiler is blown down. The valve leakage can be avoided and is a waste that should not exist.

Leakage of the blowoff valves can be readily determined by placing a recording thermometer on the blow-off line. The loss due to blowing down is an unavoidable one, but even this can be reduced by testing the boilers each day for salt. Only when a salt test shows more than 30 grains per U. S. gallon should the boilers be blown, and the engineer should tell the water tender just how many inches should be blown. Of course, where muddy water is used this loss will be high, but it should be remembered that no gain is obtained by prolonged blowing. The proper method of blowing down for mud and scale is simply to open the valve and then close it slowly.

Losses Due to Radiation

There is yet to be considered the loss due to radiation from steam and water pipes. Although most engineers are acquainted with this loss, everyone does not know the relative merit of various coverings. Table I gives this information..

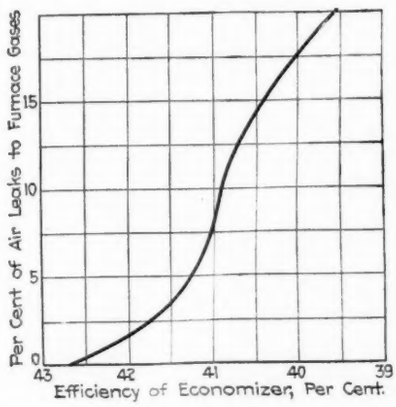


FIG. 8. INFLUENCE OF COLD-AIR LEAKS ON ECONOMIZER EFFICIENCY

Labor should be considered as relating to plant operation. Needless to say, this question should occupy the chief engineer's undivided attention, because labor is in great demand and this results in extreme unrest

of the laboring class. The question of pay also demands attention, and the rule of most large companies that a fixed limit of pay must be strictly adhered to for each individual class of labor is, in my opinion, largely responsible for the present unrest in the labor world. It is folly to pay the same wage to all men in a certain class, for when this is done the men lose their individuality and become machines. Beyond doubt all classes of men who work in the boiler room are of equal importance, but a good fireman deserves to be paid according to his proficiency. The bonus plan is not advisable for the reason that the simple things of everyday operation alter the man's proficiency to a marked degree.

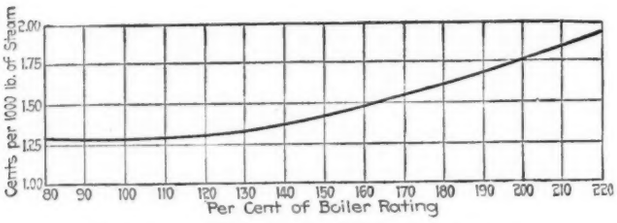


FIG. 9. EFFECT OF BOILER RATING ON MAINTENANCE COST

The old method of paying each man what he is worth, irrespective of the class of work performed, will go far toward ridding the boiler room of the present labor unrest, because it puts heart into any man to know that if he makes good the chief engineer will raise him accordingly. In the final analysis the labor cost is quite small compared to the total operating cost, and if increased labor cost will result in a decreased coal cost the result will be a net saving to the plant. The low labor costs of large plants are effected by the use of large units, and they can, therefore, afford higher wages on account of the small number of men employed. The labor problem is one that must be decided by every chief engineer as an individual.

Boiler-room maintenance varies indirectly with the net thermal efficiency of the plant. The amount of money spent in maintenance is affected by the following items: Age of plant; percentage of boiler rating developed; attendance of men; the purity of boiler-feed water; the quality of materials used for repairs, and the nature of the fuel.

TABLE I. RELATIVE MERITS OF VARIOUS PIPE COVERINGS

Nature of Covering	Thickness	B.t.u. Loss per Hour per Sq.Ft. per Degree of Average Difference in Temperature
Uncovered pipe	....	2.71
85% magnesia	1.18	0.418
85% magnesia, 2 in. section, ½ in. block	2.71	0.288
85% magnesia, two 1 in. sections	2.50	0.294
Hair felt	0.82	0.422
Rock wool	1.60	0.256
Mineral wool	1.30	0.285

The percentage of boiler rating developed has, perhaps, the greatest bearing on the maintenance charges. For instance, it affects the life of the grates, tubes, baffles, furnace and boiler auxiliaries by requiring them to do more work at a net decrease in efficiency, but just how much is a matter of conjecture. The curve shown in Fig. 9 is plotted from actual records and shows that there is some definite rate of increase.

The attendance of men is of vital importance, for to use an old proverb, "A stitch in time saves nine." Immediate attention to some small leak or break will save much time and money. Leaks in steam mains and holes in grates and furnaces never grow smaller unless they receive immediate attention.

The quality of materials used in making repairs has a direct bearing, and the best is none to good, although it must not be assumed that price and quality go hand in hand.

Furnace and Stoker Maintenance Costs

A question that is generally raised is, What should the maintenance cost be? This, of course, cannot be given for any number of plants in a definite manner, but if increased maintenance will show or, rather, give a decrease in operation, then increased maintenance is advisable. To show the trend of maintenance charges on boiler furnaces and stokers with regard to age, Table II is of value. This table is based on five boilers per unit, and the unit costs are based on the boiler-hours in service.

Boiler-Room Records

The last and most important point of economic boiler-plant operation to be considered is that of suitable boiler-room records. The records should be clear and precise and should not involve a large clerical force.

BOILER ROOM REPORT SHEET From to 1916 Month of

	Monday Date	Tuesday Date	Wed. Date	Thur. Date	Friday	Sat.	Sun.
Boiler hours in service							
Boiler hours banked							
Boiler hours out of service							
Total pounds of coal used							
Total pounds of coal used for banking boilers							
Per cent of coal used for banking boilers							
Total weight of ash							
Per cent weight of ash to weight of coal							
Total steam generator							
Maximum demand lbs. of steam per hour							
Pounds of water blown down							
Pounds of water used for makeup							
Per cent. of makeup water to total steam generated							
Average grains of salt per U. S. gallon							
Amount of boiler compound used							
Feed pumps used							
Temperature of feed water							
Temperature of water to open heater							
Temperature of water from open heater							
Temperature rise in open heater							
Temperature of water to economizer							
Temperature of water from economizer							
Temperature rise in economizer							
Temperature of flue gases entering economizer							
Temperature of flue gases leaving economizer							
Temperature drop of flue gases in economizer							
Feed-water pressure							
Steam pressure							
Steam temperature							
Degrees of superheat							
Average boiler rating							
Average stack draft							
Average air-duct pressure							
Evaporation							
Evaporation from and at 212 deg. F.							
Boiler load factor							
Coal analysis							
Thermal efficiency							

FIG. 10. WEEKLY BOILER-ROOM REPORT SHEET

A suitable set of records would be as follows: A load curve sheet which should have on it the load carried; boiler-horsepower; hours in service and banked; capacity of feed pumps on the line. This curve sheet should be spotted as often as the load condition materially changes; in most cases every fifteen minutes will be found to be the right period. There should be a weekly boiler-room report sheet. A good example is given in Fig. 10.

There should also be a daily boiler-room sheet, which should show the hours each boiler was in service, when banked, cleaned and blown down, average boiler rating, average flue-gas temperature, readings of the various water meters for each day, grains of salt in the boiler water, inches of water blown from each boiler and any other readings that may be necessary.

A monthly boiler-room sheet is also required which should be a duplicate of the weekly sheet except that it

MONTHLY STEAM REPORT	Date	
	Total Pounds	Per Cent.
Total steam generator		
Total steam used for tube blowing		
Total steam used for heating		
Total steam used for stoker auxiliaries		
Total steam used for heating boiler-feed water		
Total steam used for boiler accessories		
Total steam lost due to radiation from steam pipes		
Total steam lost due to safety valve leakage and blow-off of same		
Total steam used for miscellaneous		

FIG. 11. MONTHLY REPORT SHEET

MAINTENANCE COST RECORD BOILER NO. 1.

Boiler Horsepower..... Maker..... Maker's No..... Year Installed .....

Stoker Horsepower..... Maker..... Maker's No..... Year Installed .....

	Jan.	Feb.	Mar.	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Total
Boiler hours in service													
Boiler hours banked													
Boiler hours out of service													
Lbs. of steam generated													
Per cent. of boiler rating													
Labor cost on boiler													
Labor cost on furnace													
Labor cost on stoker													
Total labor cost													
Material cost on boiler													
Material cost on furnace													
Material cost on stoker													
Total material cost													
Total labor and material cost													
Total cost per lb. of steam (cents)													

FIG. 12. SPECIMEN MAINTENANCE COST SHEET

should have on it a space for the results of the same month one year ago and a column to show the present increase and decrease of each item.

Then there should be a monthly steam-report sheet such as is shown in Fig. 11.

A monthly heat-balance sheet with an additional item for blowdown losses, should be used, also a yearly curve sheet of the items contained on the weekly boiler-room sheet, the items being spotted daily on a suitable cross-section paper.

A station log sheet is necessary, showing the amounts of coal and water used. This should be made up on a cross-section sheet using the pounds of coal burned per day as the Y-axis and the pounds of steam used as the X-axis, and should be duplicated except that in the second sheet the pounds of water used in the plant should be the X-axis. These sheets should be spotted daily.

There should be a maintenance-cost sheet for each individual piece of apparatus similar to the one shown in Fig. 12, which is a specimen sheet for boilers, and

Year ..... YEARLY MAINTENANCE COST SHEET ..... Station

Station Capacity B.Hp. ..... Total Steam Generated

Boiler Load Factor ..... Total Coal Used

	Labor Cost	Material Cost	Total Cost	Cost per 1000 lbs. of steam
Boilers				
Furnaces				
Stokers				
Stoker drive				
Air ducts				
Blower fans				
Breeching and dampers				
Stack				
Economizer				
Ash-handling apparatus				
Coal-handling apparatus				
Feed pumps				
Meters				
House service pumps				
Piping				
Miscellaneous				

FIG. 13. YEARLY MAINTENANCE COST SHEI

also a yearly maintenance-cost sheet similar to that shown in Fig. 13.

The value of the foregoing records will be clearly seen, and it is only by the use of some such records that an engineer is able to keep tab on the actual boiler-plant operation.

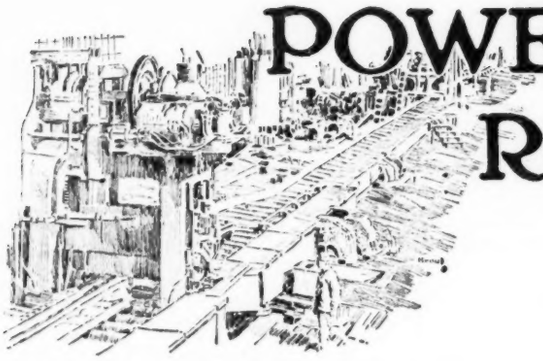
The economical operation of boiler plants can be made quite practical, and it must be remembered that it cannot be accomplished in one day or in one year, but is a matter that will always require attention to keep it where it belongs.

TABLE II. FURNACE AND STOKER MAINTENANCE CHARGES WITH REGARD TO AGE

Westinghouse Underfeed Stokers Five 600-Hp. B. & W. Water-Tube Boilers	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Boiler repairs, labor and material, dollars	174.39	288.97	110.68	281.71	331.16	416.58
Furnace, labor and material, dollars	470.39	402.14	116.20	960.99	230.07	1,597.82
Stokers, labor and material, dollars	Hand fired	Hand fired	Hand fired	Hand fired	252.48	1,333.64
Hours in service	3,717	2,361	1,136	882	12,124	22,806
Hours banked	.....	.....	8,201	7,667	4,980	10,075
Cost in cents per boiler hour, boiler	4.7	12.26	9.74	31.90	2.78	1.828
Cost in cents per boiler hour, furnace	12.68	17.00	10.29	109.00	1.89	7.01
Cost in cents per boiler hour, stoker	.....	.....	.....	.....	2.08	5.85

Roney Mechanical Stokers Five 600-Hp. B. & W. Water-tube Boilers	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Boiler repairs, labor and material, dollars	482.85	324.41	219.11	431.39	269.78	144.73
Furnace, labor and material, dollars	2,393.99	2,856.95	745.86	2,538.09	691.43	607.96
Stokers, labor and material, dollars	1,757.92	2,520.04	2,533.12	2,945.02	1,849.95	987.78
Hours in service	31,102	33,060	25,474	19,665	14,826	10,542
Hours banked	.....	.....	15,971	18,944	19,340	11,927
Cost in cents per boiler hour, boiler	1.55	0.98	0.865	2.19	1.82	1.372
Cost in cents per boiler hour, furnace	7.69	8.64	2.93	12.90	4.66	5.765
Cost in cents per boiler hour, stoker	5.65	7.63	9.93	15.00	12.46	9.46

Bayonne Chain-Grate Stokers Five 600-Hp. B. & W. Water-Tube Boilers	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Boiler repairs, labor and material, dollars	.....	23.72	53.70	348.89	1,351.32	358.23
Furnace, labor and material, dollars	.....	211.00	1,780.13	1,421.16	2,708.80	1,501.97
Stokers, labor and material, dollars	.....	39.49	3,621.17	2,716.96	2,502.79	2,558.55
Hours in service	.....	17,056	35,322	35,749	30,984	34,068
Hours banked	.....	.....	2,464	1,068	1,552	9.15
Cost in cents per boiler hour, boiler	.....	0.139	0.152	0.976	4.36	1.52
Cost in cents per boiler hour, furnace	.....	1.238	5.04	3.980	8.750	4.42
Cost in cents per boiler hour, stoker	.....	0.231	10.25	7.60	8.08	7.52



POWER DRIVES FOR ROLLING MILLS

By

W. O. Rogers

Several types of mills are described, together with something regarding the process in rolling steel into various products, from the ingot into slabs, billets, skelp, plates and pipes.

ROLLING mills are generally named after the material produced in them. Blooming mills come first as this mill rolls ingots, as they are classed, into blooms or billets, and all material rolled in a steel mill must first go through the blooming mill to reduce it to the proper size. These mills are made two-high reversing or three-high running constantly in one direction.

A slabbing mill is somewhat similar to a two-high reversing blooming mill and produces slabs, which are afterward rolled into plates. A billet mill is generally of the continuous type with rolls in tandem, and it rolls material coming from the blooming mill into billets of suitable size for the finishing mill. A plate mill is either two-high reversing or three-high running continuously in one direction, and is used to roll slabs into plates.

Structural mills are usually three-high and are used for rolling girders, heavy angles, channels, etc. In small mills this material may be rolled by the reversing blooming mill. Merchant mills are used for rolling small angles, channels and various types of profiles. They are usually three-high with the finishing stand, sometimes two-high.

Bar mills are usually three-high and generally consist of a roughing stand and a separate finishing stand. This mill is used for rolling bars of various sections and sizes. Rod mills are a special type of bar mill and roll small sections at high speed. Rail mills generally roll blooms or heavy billets into rails. The mills are made both two-high and three-high. Sheet mills roll bars into sheets of various gages and thicknesses. These mills are always two-high and generally have separate roughing and finishing rolls. Other types of mills are used, such as wire mills, hoop mills, etc.

A bloom is a bar of metal that is rolled from an ingot. In a previous article it was shown that ingots were formed in molds, the metal for filling them coming from the converter, in the bessemer process, and also from the

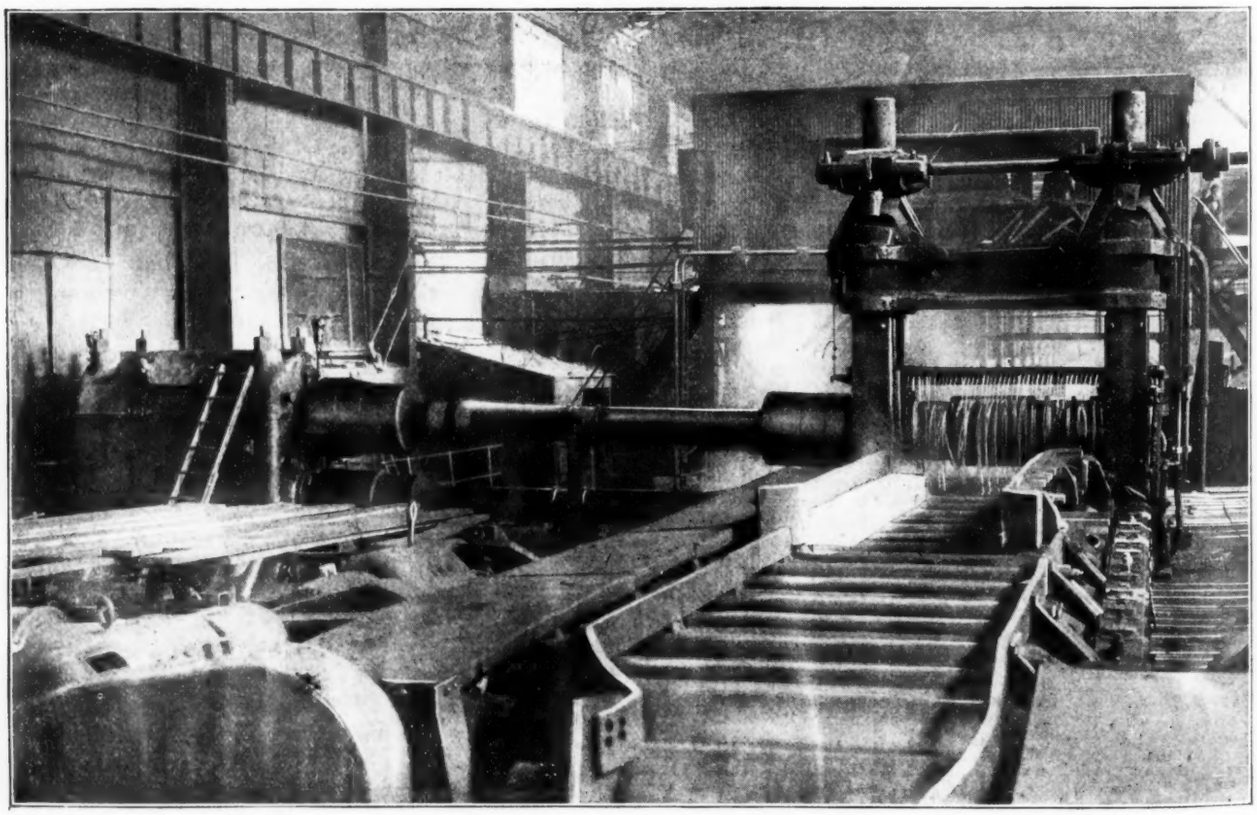


FIG. 1. A 42-IN. REVERSING BLOOMING MILL DRIVEN BY A 54 x 66-IN. 12,000-HP. STEAM ENGINE

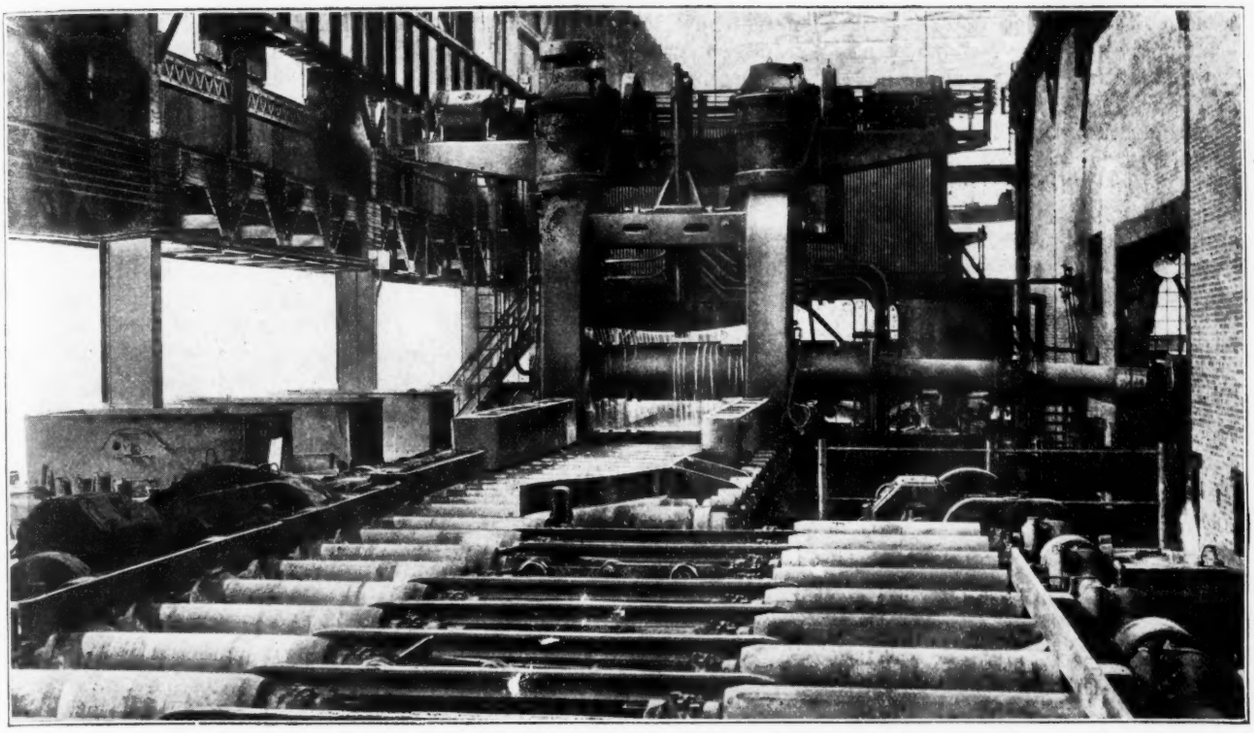


FIG. 2. A 44-IN. REVERSING BLOOMING MILL AND TRANSFER TABLE

openhearth furnace. These ingots are stripped of the mold as soon as they become sufficiently solidified. If the ingot does not come out easily, the plunger of the stripping machine holds down the ingot by hydraulic pressure as the mold is drawn upward. Electrically operated stripping machines are also used, but I saw neither kind in operation. After stripping the ingot it is either placed in a soaking pit or taken direct to the blooming mill, where it is rolled into the required shape.

When hot metal is put through two rotating rolls, it will of course come out on the other side of the roll at a reduced thickness, the metal being compressed in the process. The reduction in area at each pass will vary between 5 and 50 per cent of the original. In making steel rails from ingots, say 18 in. square, in 22 passes, this amount of vertical squeeze will vary, the time for the operation being about five minutes, the speed of the metal through the rolls being in the neighborhood of ten miles per hour.

The parts of a rolling mill vary according to the kind of mill. Plate and rectangular mills have flat rolls, but the rolls may also be made with grooves and with collars. Fig. 1 shows a 42-in. reversing mill at the main plant of the Youngstown Sheet and Tube Co. It is driven by a 54 x 66-in. 12,000-hp. engine. By reversing is meant that the direction of rotation of the engine and rolls is reversed at each pass of the metal through the mill. The illustration shows the ingot partly rolled and also the spindles which drive the rolls, each having a coupling at the end. On a two-high mill, Fig. 2, the roll table is stationary. This table is fitted with live rolls for handling the heavy pieces of metal, and the rolls are placed in front of and behind the roll train. With a three-high mill the tables are generally raised and lowered together by either hydraulically or electrically operated mechanism. In some cases the table is pivoted near the center, so that the end next to the rolls can be tilted upward in order to bring the piece being rolled between the guides that direct it to the mill. The rolls on this table revolve and are driven by an electric motor to move the metal being rolled back and forth.

Some mills are equipped with a transfer table that moves from one roll train to another, carrying the rolled metal with it. The rolls of this table are motor-driven. Fig. 2 shows a transfer table of a 44-in. reversing blooming mill. The motors for manipulating the train rolls and transfer-table rolls are of the inclosed mill type, and are shown in both Figs. 1 and 2.

Fig. 3 shows a 44-in. reversing blooming mill and brings out in particular the manipulator. This is moved sideways across the table rolls and is used to transfer the metal being rolled from one pass to another. On lifting tables fingers are used to tip the piece from one side to the other. This is done by lowering the table, when the edge of the piece of metal will rest upon the finger, and it is then tipped. Three-high blooming mills use this kind of manipulator to a large extent, but on reversing blooming-mill work the piece is frequently tipped by hand by means of a forked tool in the hands of the rollers.

The manipulator consists of two long, heavy steel plates placed vertically on edge over the live table rollers, one set being on the table on each side of the roll stand. The plates are supported from independent movable beams underneath the table rollers. These beams are carried on guide collars attached at the end to hydraulic pistons, when that system is used, or through a rack and pinion to electric motors which move the plates back and forth across the table rollers. Thus a piece of steel can be held between the two guides and moved across the rollers as desired.

A three-high 110-in. plate mill is shown in Fig. 4. The hydraulic lifting table is operated by means of a cylinder placed underneath the table. A piston and rod are connected by means of a link and rod to a system of bell cranks, which moves the table up or down as the piston is forced from one end of the cylinder to the other. If the table is motor-operated, reduction gears

are used to connect the motor to a crankshaft, which, by means of a connecting-rod, moves a bell crank, which in turn moves the table up and down. In both systems the table is usually counterweighted.

The largest plate mill in the world is at the Lukens Steel Co.'s Plant at Coatesville, Penn. It is a 204-in. mill used for rolling the flat circles for boiler heads and boiler plates. It is of the four-high reversing type in which two working rolls, each weighing 30 tons, are backed up by two larger rolls 50 in. in diameter and weighing 60 tons each. The mill is over 41 ft. from the bottom of the housing to the top of the cylinder on top of the housing.

Fig. 5 shows a 46-in. slabbing-mill engine and complete equipment. This is a compact installation and gives a good idea of the immensity of the mill, as compared to the workmen standing at the stand. Even with the rigid construction of these mills it is surprising how the stands withstand the shock and strain. As a matter of fact, the most serious difficulty encountered in rolling steel is the bending or breaking of the rolls from being placed under too severe a strain. This may be because the rolls have been set too close together or because the metal is too cold.

In rolling plates, the ingot, which may weigh anywhere from two to ten tons, is first cogged down in the slabbing mill, where a long flat piece of metal is produced. This type of mill is frequently of the two-high stand universal reversing type. In rolling hot metal there is always some expansion sideways, such that the sides will be bulged. This deformity is taken care of in what is termed a universal mill, by the arrangement of an auxiliary set of vertical rolls so placed that the piece passes through them just after leaving the horizontal rolls. The vertical rolls can be adjusted to any width of the mill and are given just enough pressure to keep the edge of the piece even. These vertical rolls are used with two-high and three-high mills, and with vertical rolls on both sides of the horizontal rolls.

After the piece has been rolled to the desired thickness, the end is sheared off and the remainder is cut up into what are known as slabs of whatever size required. The slabs are taken to a heating furnace and heated to about 1300 deg. C., or 2372 deg. F. They are then rolled in either a three-high mill or a two-high reversing mill. At the last pass of the plate through the rolls, a workman throws salt on the surface of the plate. The salt is carried into the rolls, over which water is trickling, with the plate, as shown in Figs. 1 and 2. This water is to keep the rolls cool. When the water is pressed against the hot plate, it flashes into steam, which, in conjunction with the salt, causes a series of small but violent explosions, which result in blowing off the scale from the top of the plate and give it a smooth surface.

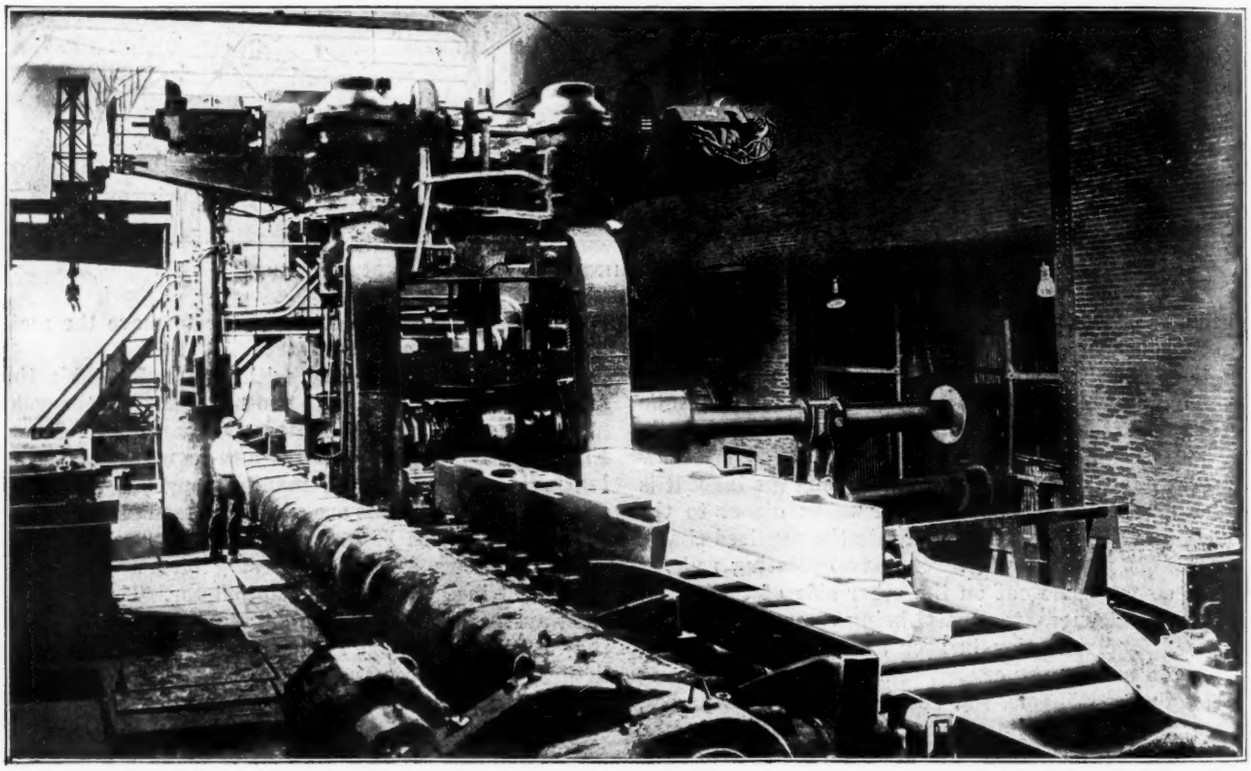


FIG. 3. REVERSING 44-IN. BLOOMING MILL WITH THE MANIPULATOR IN THE FOREGROUND

When the plate nears the desired thickness a gager tries it, and when it is of the right size it is passed on to a set of straightening rolls and then to the cooling table. After cooling, it is sheared to the size required.

Some mills are devoted to the manufacture of steel rails for railroad use. In this type the ingot weighs about three tons. It is heated until it has a uniform temperature and is then rolled into blooms in either a three-high mill or a two-high reversing mill. It requires about eight passes through the rolls to reduce the ingot to an 8-in. square bloom, the amount of reduction per pass averaging about 16 per cent of the original area of the bloom. After cutting off the end to remove what is termed the pipe on the forward end, and the irregularity caused by the rolls at the other, the piece is cut into two blooms. These blooms are reheated and passed through a series of roll stands, usually being rolled into ten shapes, each one taking more and more the form of the

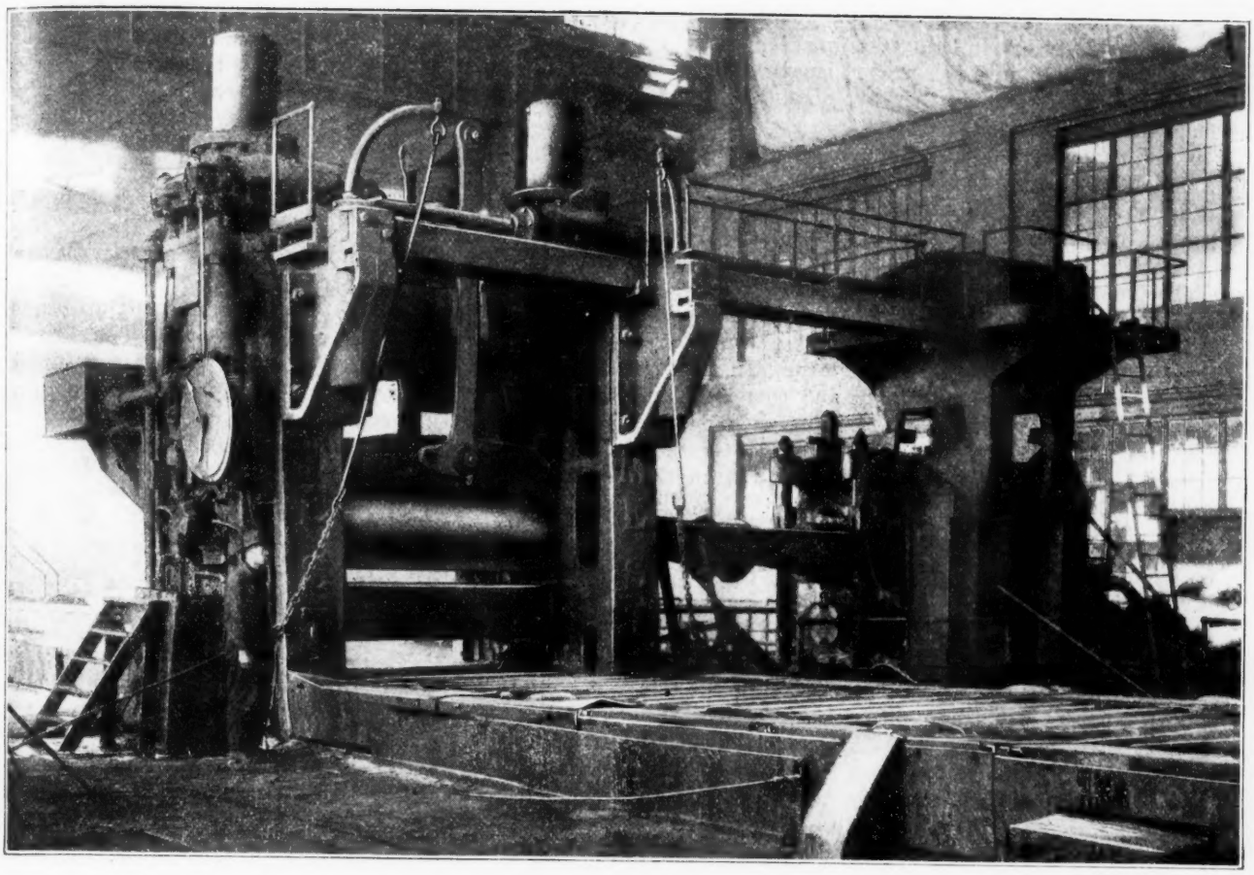


FIG. 4. A THREE-HIGH 110-IN. PLATE MILL WITH HYDRAULICALLY OPERATED LIFTING TABLE

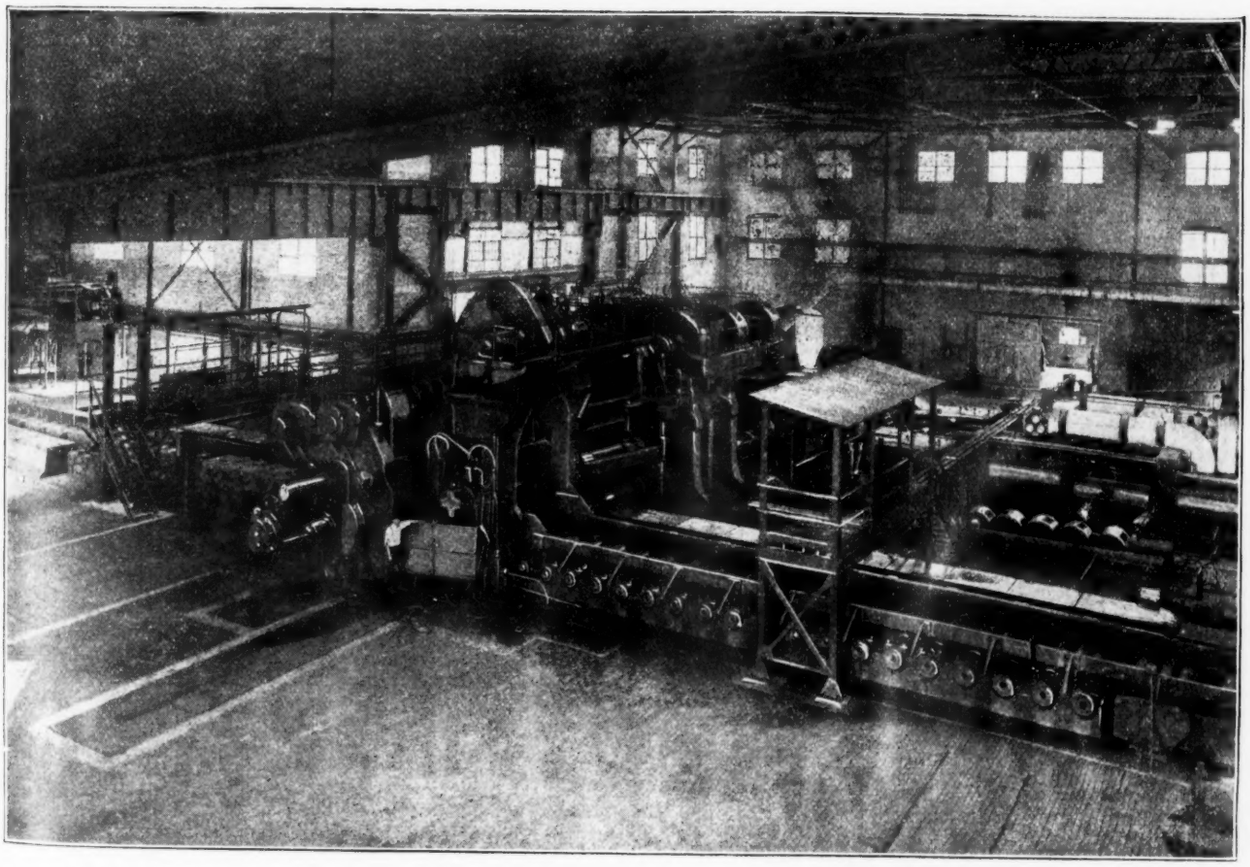


FIG. 5. COMPLETE EQUIPMENT OF A 46-IN. SLABBING MILL, ENGINE SHOWN ON THE FAR RIGHT SIDE

finished rail, the last stand being the finishing one. The rails are then sawed into the proper length and go to a cooling table, after which they are straightened and the fishplate holes are made.

It is a difficult matter for a visitor to enter a tube mill; that is, a mill where steel pipes are made. Most manufacturers seem to think it advisable to surround the process with secrecy. I was fortunate, however, in going through the tube mill of the Youngstown Sheet and Tube Co. although no photographs were taken.

Pipes are made from skelp, which is a narrow plate about 25 ft. long, the width and thickness of which are governed by the size of the pipe to be made. In making large-sized pipe, the skelp is heated and then bent up into a rough circular form by passing it sidewise through rolls, so that the edge overlaps. It is then passed through a stand of rolls with the weld on the top. A mandrel mounted on a long shaft is inserted between the rolls, and as the mandrel is bullet-shaped on the head end and of the inside diameter of the pipe, the rolls press the welding edges together over the mandrel, and the pipe passes out through the mill. The pipe is then straightened and the ends cut off, after which it is tested for tightness of the weld by hydraulic pressure.

Small sizes of the lap-weld joint are drawn through a bell-shaped die, which welds the two edges of the skelp together during its passage through it. Butt-welded pipes are made in much the same way. The skelp is heated to a welding temperature, and it is then drawn through a bell die, which forces the skelp into a circular form and welds the edges together without lapping.

(*Various other types of shears and rolling mills will be taken up in the next article.*)

Tables for Computing Combustion Data From CO_2 Readings

AFTER obtaining the percentage of CO_2 in the flue gas, from an Orsat apparatus or a recorder, the next step is to interpret this value in terms of excess air, air supplied and heat loss in the excess air. The accompanying tables have been prepared to give a general idea of how these items change with variations in the CO_2 readings and also to furnish a ready means of quick calculation.

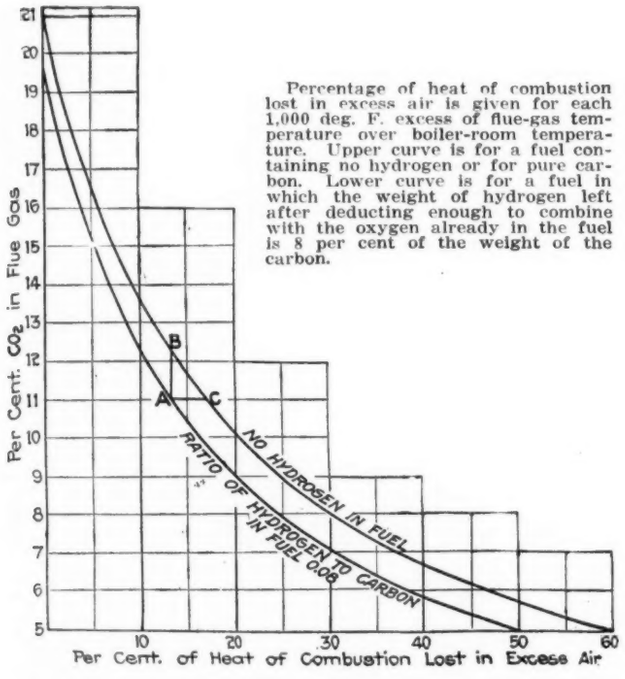

Percentage of heat of combustion lost in excess air is given for each 1,000 deg. F. excess of flue-gas temperature over boiler-room temperature. Upper curve is for a fuel containing no hydrogen or for pure carbon. Lower curve is for a fuel in which the weight of hydrogen left after deducting enough to combine with the oxygen already in the fuel is 8 per cent of the weight of the carbon.
Per Cent. CO_2 in Flue Gas
Per Cent. of Heat of Combustion Lost in Excess Air
A
B
C
NO HYDROGEN IN FUEL
RATIO OF HYDROGEN TO CARBON IN FUEL 0.08

CHART SHOWING EFFECT OF HYDROGEN IN FUEL ON HEAT LOSS AS INDICATED BY CO_2 READINGS

The chart, which was plotted from values in the tables, is given to point out the effect of varying amounts of hydrogen in the fuel. For example, the line *AB* shows that an excess air heat loss of 13 per cent would be indicated by 11 per cent CO_2 with a fuel containing 8 per cent as much hydrogen as carbon, and by 12.3 per cent CO_2 with a fuel containing only carbon. The line *AC* shows that 11 per cent CO_2 indicates 13 per cent loss when the hydrogen-carbon ratio is 0.08 and 17 per cent loss with pure carbon. The curves also show clearly the effect of a given change in CO_2 at different points. A drop in CO_2 from 16 to 15 per cent (with pure carbon) represents an increase of only about 2 per cent in the heat loss, while a drop from 6 to 5 per cent CO_2 represents a heat-loss increase of about 13 per cent.

TABLE I. PERCENTAGES OF EXCESS AIR INDICATED BY VARIOUS CO_2 READINGS FOR DIFFERENT RATIOS OF HYDROGEN TO CARBON IN COAL

Per Cent CO_2	Pure Carbon	$\frac{H}{C} = 0.02$	$\frac{H}{C} = 0.04$	$\frac{H}{C} = 0.06$	$\frac{H}{C} = 0.08$
20.9	0.0	.....	.....	.....	.....
20.5	1.95	0.33	.....	.....	.....
20.0	4.50	2.83	1.16	.....	.....
19.5	7.18	5.47	3.75	2.02	0.30
19.0	10.00	8.22	6.44	4.65	2.87
18.5	12.97	11.16	9.32	7.47	5.63
18.0	16.1	14.2	12.29	10.39	8.48
17.5	19.4	17.4	15.5	13.5	11.52
17.0	22.9	20.9	18.8	16.8	14.7
16.5	26.7	24.6	22.5	20.4	18.2
16.0	30.6	28.4	26.2	24.0	21.8
15.5	34.8	32.5	30.2	28.0	25.7
15.0	39.3	36.9	34.6	32.2	29.8
14.5	44.1	41.6	39.2	36.7	34.2
14.0	49.3	46.7	44.2	41.6	39.0
13.5	54.8	52.1	49.4	46.8	44.0
13.0	60.8	58.0	55.2	52.4	49.6
12.5	67.2	64.3	61.4	58.4	55.5
12.0	74.2	71.1	68.1	65.0	61.9
11.5	81.7	78.5	75.3	72.1	68.8
11.0	90.0	86.6	83.2	79.9	76.5
10.5	99.0	95.4	91.9	88.3	84.8
10.0	109.0	105.2	101.5	97.7	94.0
9.5	120.0	116.0	112.0	108.1	104.1
9.0	132.2	128.0	123.8	119.5	115.3
8.5	146.	141.	137.	132.	127.9
8.0	161.	156.	152.	147.	142.
7.5	179.	174.	168.	163.	158.
7.0	199.	193.	187.	182.	176.
6.5	222.	215.	209.	203.	197.
6.0	248.	242.	235.	229.	222.
5.5	280.	273.	266.	258.	251.
5.0	318.	310.	302.	294.	286.
4.5	364.	356.	347.	338.	329.
4.0	423.	412.	402.	392.	382.

In computing the tables, it was assumed that the combustion of the carbon and the hydrogen was complete, and further that the effect of sulphur or other

TABLE II. AIR PER POUND OF COMBUSTIBLE BY WEIGHT AND BY VOLUME AT 70 DEG. F. AND 14.7 LB. PER SQ.IN. WITH VARIOUS PERCENTAGES OF CO_2

Per Cent CO_2	Pure Carbon — Weight, Lb.	Pure Carbon — Volume, Cu.Ft.	$\frac{H}{C}$ = 0.02 Weight, Lb.	$\frac{H}{C}$ = 0.02 Volume, Cu.Ft.	$\frac{H}{C}$ = 0.04 Weight, Lb.	$\frac{H}{C}$ = 0.04 Volume, Cu.Ft.	$\frac{H}{C}$ = 0.06 Weight, Lb.	$\frac{H}{C}$ = 0.06 Volume, Cu.Ft.	$\frac{H}{C}$ = 0.08 Weight, Lb.	$\frac{H}{C}$ = 0.08 Volume, Cu.Ft.	Per Cent CO_2
20.9	11.52	153.8	.....	.....	.....	.....	.....	.....	.....	.....	20.9
20.5	11.75	156.8	12.02	160.5	.....	.....	.....	.....	.....	.....	20.5
20.0	12.04	160.7	12.32	164.5	12.58	167.9	.....	.....	.....	.....	20.0
19.5	12.35	164.8	12.64	168.7	12.91	172.4	13.16	175.7	13.40	178.9	19.5
19.0	12.67	169.2	12.96	173.0	13.24	176.8	13.50	180.2	13.74	183.4	19.0
18.5	13.01	173.7	13.32	177.8	13.60	181.6	13.86	185.0	14.11	188.4	18.5
18.0	13.38	178.6	13.68	182.6	13.97	186.5	14.24	190.1	14.49	193.4	18.0
17.5	13.76	183.7	14.07	187.8	14.36	191.7	14.64	195.4	14.90	198.9	17.5
17.0	14.16	189.1	14.48	193.3	14.78	197.3	15.06	201.1	15.33	204.7	17.0
16.5	14.59	194.8	14.92	199.2	15.24	203.5	15.53	207.3	15.80	210.9	16.5
16.0	15.05	200.9	15.38	205.3	15.70	209.6	16.00	213.6	16.28	217.3	16.0
15.5	15.53	207.4	15.88	212.0	16.20	216.3	16.51	220.4	16.79	224.2	15.5
15.0	16.05	214.3	16.40	218.9	16.74	223.5	17.05	227.6	17.35	231.6	15.0
14.5	16.61	221.7	16.97	226.6	17.31	231.1	17.64	235.5	17.93	239.4	14.5
14.0	17.20	229.6	17.53	234.7	17.93	239.4	18.27	243.9	18.57	247.9	14.0
13.5	17.83	238.1	18.22	243.2	18.59	248.2	18.93	252.7	19.24	256.9	13.5
13.0	18.52	247.3	18.93	252.7	19.31	257.8	19.66	262.5	19.99	266.9	13.0
12.5	19.26	257.1	19.68	262.7	20.07	267.9	20.44	272.9	20.77	277.3	12.5
12.0	20.06	267.9	20.50	273.7	20.91	279.2	21.29	284.2	21.64	288.9	12.0
11.5	20.94	279.5	21.38	285.4	21.80	291.0	22.19	296.2	22.56	301.2	11.5
11.0	21.89	292.2	22.36	298.5	22.80	304.4	23.20	309.7	23.58	314.8	11.0
10.5	22.93	306.1	23.41	312.5	23.87	318.7	24.29	324.3	24.68	329.5	10.5
10.0	24.08	321.4	24.59	328.3	25.06	334.6	25.50	340.4	25.91	345.9	10.0
9.5	25.34	338.3	25.88	345.5	26.38	352.2	26.84	358.3	27.26	363.9	9.5
9.0	26.75	357.1	27.31	364.6	27.83	371.5	28.32	378.1	28.76	384.0	9.0
8.5	28.32	378.1	28.92	386.1	29.47	393.4	29.98	400.2	30.45	406.5	8.5
8.0	30.10	401.8	30.73	410.3	31.31	418.0	31.85	425.2	32.34	431.7	8.0
7.5	32.10	428.6	32.77	437.5	33.39	445.8	33.96	453.4	34.48	460.3	7.5
7.0	34.40	459.2	35.11	468.7	35.76	477.4	36.37	485.5	36.92	492.9	7.0
6.5	37.04	494.5	37.80	504.6	38.50	514.0	39.15	522.7	39.74	530.5	6.5
6.0	40.13	535.7	40.94	546.6	41.70	556.7	42.40	566.0	43.03	574.5	6.0
5.5	43.78	584.4	44.66	596.2	45.49	607.3	46.24	617.3	46.93	626.5	5.5
5.0	48.15	642.9	49.13	655.9	50.02	667.8	50.85	678.9	51.60	688.9	5.0
4.5	53.50	714.3	54.57	728.5	55.56	741.7	56.47	753.9	57.30	765.0	4.5
4.0	60.19	803.6	61.39	819.6	62.50	834.4	63.52	848.0	64.44	860.3	4.0

TABLE III—HEAT LOST TO STACK IN EXCESS AIR PER POUND OF COMBUSTIBLE FOR EACH 1,000 DEG. F. EXCESS OF GLUE-GAS TEMPERATURE ABOVE BOILER-ROOM TEMPERATURE

Values given in B.t.u. and in Percentage of Heat Available in the Combustible

Per Cent CO_2	Pure Carbon — B.t.u.	Pure Carbon — Per Cent	$\frac{H}{C}$ = 0.02 B.t.u.	$\frac{H}{C}$ = 0.02 Per Cent	$\frac{H}{C}$ = 0.04 B.t.u.	$\frac{H}{C}$ = 0.04 Per Cent	$\frac{H}{C}$ = 0.06 B.t.u.	$\frac{H}{C}$ = 0.06 Per Cent	$\frac{H}{C}$ = 0.08 B.t.u.	$\frac{H}{C}$ = 0.08 Per Cent	Per Cent CO_2
20.9	0	0	.....	.....	....	.....	.....	.....	.....	.....	20.9
20.5	54	0.37	9	0.06	...	.....	.....	.....	.....	.....	20.5
20.0	124	0.85	81	0.52	35	0.21	.....	.....	.....	.....	20.0
19.5	199	1.36	157	1.01	112	0.68	63	0.36	10	0.05	19.5
19.0	277	1.89	236	1.52	192	1.17	144	0.83	92	0.50	19.0
18.5	359	2.46	321	2.06	278	1.69	231	1.33	181	0.98	18.5
18.0	445	3.05	408	2.63	367	2.22	322	1.84	272	1.48	18.0
17.5	537	3.68	501	3.22	462	2.80	418	2.39	369	2.01	17.5
17.0	634	4.34	600	3.86	562	3.41	520	2.98	473	2.57	17.0
16.5	737	5.05	707	4.55	671	4.07	630	3.61	585	3.18	16.5
16.0	847	5.80	817	5.25	783	4.74	744	4.26	700	3.80	16.0
15.5	963	6.59	935	6.01	903	5.47	866	4.97	824	4.48	15.5
15.0	1,087	7.45	1,062	6.83	1,032	6.25	997	5.72	956	5.20	15.0
14.5	1,220	8.36	1,197	7.70	1,170	7.09	1,137	6.52	1,098	5.97	14.5
14.0	1,363	9.33	1,343	8.64	1,319	7.99	1,288	7.39	1,251	6.80	14.0
13.5	1,516	10.38	1,498	9.64	1,476	8.95	1,448	8.30	1,411	7.67	13.5
13.0	1,680	11.51	1,668	10.73	1,648	9.99	1,623	9.30	1,591	8.65	13.0
12.5	1,858	12.73	1,848	11.89	1,832	11.10	1,809	10.37	1,779	9.68	12.5
12.0	2,050	14.1	2,045	13.15	2,033	12.32	2,012	11.54	1,986	10.80	12.0
11.5	2,260	15.4	2,256	14.5	2,248	13.62	2,231	12.79	2,207	12.00	11.5
11.0	2,489	17.0	2,490	16.0	2,486	15.1	2,472	14.2	2,452	13.33	11.0
10.5	2,738	18.8	2,744	17.6	2,744	16.6	2,734	15.7	2,717	14.8	10.5
10.0	3,013	20.6	3,026	19.5	3,030	18.4	3,025	17.3	3,012	16.4	10.0
9.5	3,318	22.7	3,336	21.5	3,345	20.3	3,345	19.2	3,336	18.1	9.5
9.0	3,656	25.0	3,679	23.7	3,695	22.4	3,700	21.2	3,697	20.1	9.0
8.5	4,034	27.6	4,065	26.1	4,088	24.8	4,099	23.5	4,100	22.3	8.5
8.0	4,459	30.5	4,499	28.9	4,529	27.4	4,547	26.1	4,555	24.8	8.0
7.5	4,940	33.8	4,989	32.1	5,028	30.5	5,054	29.0	5,068	27.6	7.5
7.0	5,490	37.6	5,550	35.7	5,598	33.9	5,633	32.3	5,655	30.8	7.0
6.5	6,126	41.9	6,195	39.8	6,255	37.9	6,299	36.1	6,330	34.4	6.5
6.0	6,866	47.0	6,950	44.7	7,023	42.6	7,079	40.6	7,121	38.7	6.0
5.5	7,742	53.0	7,844	50.5	7,932	48.1	8,002	45.9	8,056	43.8	5.5
5.0	8,793	60.2	8,914	57.3	9,021	54.7	9,10	52.2	9,177	49.9	5.0
4.5	10,077	69.0	10,221	65.7	10,351	62.7	10,458	60.0	10,545	57.3	4.5
4.0	11,682	80.0	11,859	76.3	12,017	72.8	12,149	69.7	12,259	66.7	4.0

impurities might be neglected. It was also assumed that the percentage of carbon, hydrogen and oxygen in the coal was known, as well as the CO_2 reading. Table I gives the percentages of excess air indicated by the various CO_2 readings for ratios of net hydrogen to carbon in the coal of 0.02, 0.04, 0.06 and 0.08. By net hydrogen is meant that part of the hydrogen in the coal which must be supplied with oxygen from the air. Each pound of oxygen in the coal has combined with, or will combine with, one-eighth of a pound of hydrogen. Therefore, the oxygen already in the coal will take care of one-eighth of

its own weight of hydrogen, and the remainder of the hydrogen in the coal is that which has been designated as net hydrogen.

Table No. II shows the weight of air and the volume of air per pound of combustible, the volume being measured at 70 deg. and 14.7 lb. per sq.in. absolute, or atmospheric pressure. By combustible is meant here the weight of carbon plus the weight of net hydrogen. In this table, as before, the percentage of CO_2 is the argument, and the weight and volume respectively of air per pound of combustible are given for the same ratios of net hydrogen to carbon as are used in Table I.

Table III gives the heat loss due to excess air in B.t.u. per pound of combustible and in percentage of the heat supplied for each 1,000 deg. of difference between the flue-gas temperature and that of the boiler room. It is to be noted that Table II gives the total air supplied per pound of combustible, not simply the excess, while Table III gives the heat loss to the stack in the excess air and not in the total air supplied. The values are given in this particular way as this seems to be the most convenient for general use.

As an example of the use of the tables assume a coal containing 75 per cent carbon, 5.5 per cent hydrogen and 10 per cent oxygen and that the flue gas is at a temperature 640 deg. F. above boiler-room temperature and contains 11 per cent CO_2. The weight of hydrogen per pound of coal is then 0.055 lb., and since the weight of oxygen is 0.10 lb., the weight of net hydrogen will be $0.055 - \frac{0.10}{8}$, or 0.0425 lb. The ratio of net hydrogen to carbon therefore will be $\frac{0.0425}{0.75}$, or 0.0567. This value is close enough to 0.06 so that we are justified in using that column in the tables.

Referring to Table I, under hydrogen-to-carbon-ratio 0.06 at 11 per cent CO_2 we find the percentage of excess air as 79.9. In Table II in the corresponding column on the corresponding line we find there were actually supplied 23.21 lb., or 309.9 cu. ft., of air for each pound of combustible. From Table III the excess air heat loss would be 2,474 B.t.u., or 14.2 per cent of the heat in the combustible if the flue gas temperature were 1,000 deg. F. above that of the boiler room.

In each pound of coal the combustible is 0.75 + 0.0567, or 0.8067, or nearly 0.807 lb. The weight of air, the volume of air and the heat lost to the stack in B.t.u. for each pound of combustible would be multiplied by this value to get the corresponding value per pound of coal. Further, the heat loss in B.t.u. per pound of coal and in percentage should be multiplied by one one-thousandth of the temperature rise. It should be noted that the fraction of combustible in the coal is not to be used with the percentage of excess air or the percentage of heat lost in the excess air, since these values are ratios and have already taken account of the percentage of combustible. To sum up, then, the condition assumed shows that we have 79.9 per cent excess air, that we have supplied $23.21 \times 0.807 = 18.76$ lb. of air per pound of coal, $309.9 \times 0.807 = 250$ cu.ft. of air per pound of coal, that $2,474 \times 0.807 \times 0.640 = 1,278$ B.t.u. per pound of coal has been lost to the stack in the excess air, and finally that this loss is $14.2 \times 0.640 = 9.09$ per cent of the available heat.

This table brings out very clearly the necessity of keeping down the amount of excess air to the lowest practical value, but it does not show the danger in reducing the excess air until there may be incomplete combustion of a part of the carbon. In trying for a high CO_2 reading with its accompanying reduction of losses due to excess air, it must be remembered that the incomplete combustion of even a small amount of carbon will more than wipe out the saving due to the decreased air supply. In connection with CO_2 recording apparatus, then, some method of indicating the presence of CO should be provided.

Adjustment of Valve-Timing Mechanism

BY E. E. SNOW

In gas and oil engines it is customary to have the valve pushrod provided with right- and left-hand threaded ends. To obtain adjustment of the valve timing, it is necessary to stop the engine, open the

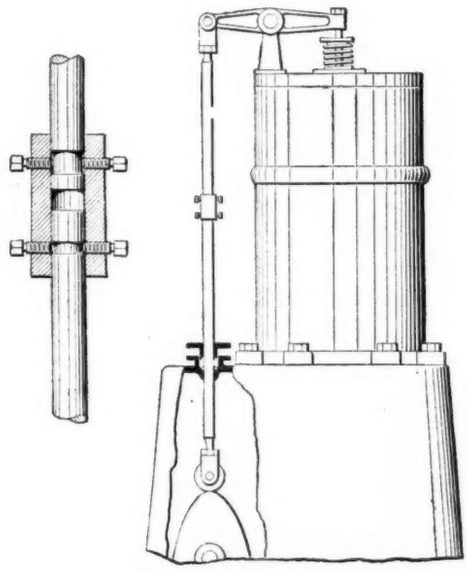


FIG. 1. COLLAR ON PUSHROD ASSISTS IN CORRECT TIMING OF INTERNAL-COMBUSTION ENGINE

crankcase and loosen the locknut at the lower end of the rod before the rod length can be altered. The consequence is that the valve timing of the engine is always secured when the engine is cold. Owing to the variation in length of rod when cold and when warmed up, the timing as made when cold is never maintained. There is always some wear and backlash to distort the valve timing.

To allow the valves to be timed while the engine is running, an enterprising engineer made collars or sleeves, as shown in the sketch. The valve pushrod is cut in two pieces and grooves made in the ends inclosed by the collar. Two setscrews are fitted into the grooves, preventing looseness.

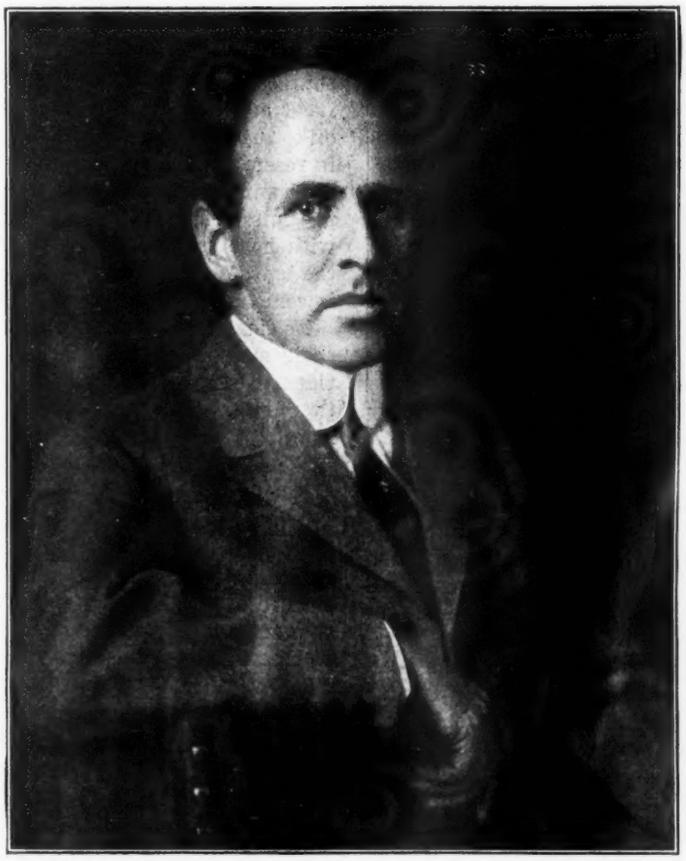
To adjust the timing, the locknut at the upper end of the rod is slackened off, the setscrew is loosened and the rod turned; this shortens or lengthens the rod as the case may be. As soon as the engineer has secured the valve "lead" desired, the locknut is tightened and the setscrew adjusted. This is a practical idea and is of immense service where the engine is of the vertical type.

Robert H. Fernald

A Brief Biographical Sketch Outlining His Early Life and His Research Work for the Aid and Advancement of Engineering Science, Including Important Experimental Work and Testing of Mineral Fuels in Gas Producer Plants and in Steam-Boiler Furnaces in the United States and Europe for the United States Geological Survey and the Bureau of Mines.

ROBERT H. FERNALD, Professor in Charge of the Department of Mechanical Engineering at the University of Pennsylvania, has given to the engineering world a life of service. The greater part of his life has been devoted to teaching, but probably the most important work done by him was in connection with fuel investigation.

He was born Dec. 19, 1871, in Orono, Maine, and was graduated from the Mechanical Engineering Department of the Maine State College (now the University of Maine) in 1892. At that time his father, Merritt C. Fernald was president of the college. After a year spent in further study at the Massachusetts Institute of Technology, he went to the Case School of Applied Science in Cleveland as an instructor, later becoming an assistant professor. In 1902 he was made Professor of Mechanical Engineering at Washington University, St. Louis, Mo. While there he began his connection with the Technologic Branch of the United States Geological Survey. This connection resulted in some very important work with reference to the question of fuels. In 1907 he returned to the Case School as head of the Department of Mechanical Engineering and in 1912 took his present position at the University of Pennsylvania as Professor of Dynamical Engineering. In the fall of 1908 Professor Fernald, who had been actively interested in the analyzation and testing of mineral fuels as carried on by the United States Geological Survey, including trials of coal, lignite and peat in gas producers, was sent on a trip of inspection to those European countries where gas producers and gas engines were in more extensive use than in the United States to visit the plants that had been most successful in utilizing fuels of poor quality. Plants in ten European countries were visited during a two months' journey. A detailed study of all the plants visited was impossible owing to the limited time available, but Professor Fernald obtained knowledge of some interesting features of European practice which differ from those of this country and collected interesting data concerning various grades of fuel (particularly low-grade fuel) in use and the results obtained. Prior to his trip to Europe Professor Fernald had been interested in the testing work of the United States Geological Survey in this country, the object being to find out in what ways the mineral fuels of the United States could be utilized most efficiently, and by what means deposits of low-grade fuel that were lying undeveloped or were being wasted could be made of immediate or prospective importance as assets of the mineral wealth of the nation. This work was started in 1904 in St. Louis and continued under the direction of the Survey until 1910, when all fuel-testing work was transferred by an act of Congress to the Bureau of Mines.



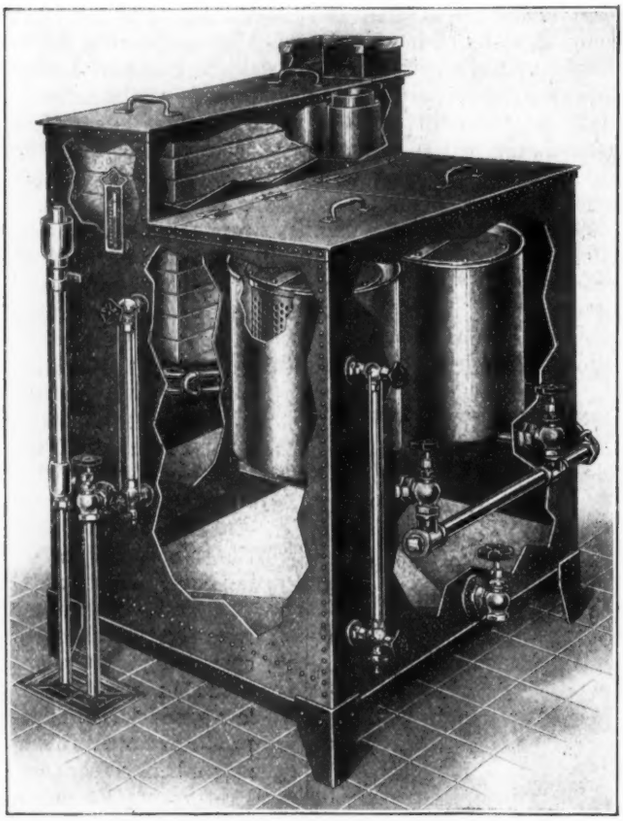
Mines throughout the country were requested to contribute two carloads of coal each, one to be burned under a boiler, the steam to be used in a steam engine, and the other load to be burned in a gas producer and the gas to be burned in a gas engine. The services of Professor Breckenridge, now of Yale University, were secured to take charge of the steam tests, and Professor Fernald, who was then at the University of Washington, assumed the responsibility of the gas-producer tests. The results of these investigations is a surprising development in the use of low-grade fuels in gas-producer plants and steam-boiler furnaces. Professor Fernald's activities were by no means confined to the university and fuel investigations. As a side line he performed considerable consulting-engineering service, and in Cleveland, Ohio, as a consulting engineer he worked on the street-car ventilator acceptance tests. He is the co-author with George A. Orrok of a book on "Engineering of Power Plants" and of a num-

ber of reports and bulletins on the conservation of the fuel resources in the United States and Europe, written for the Geological Survey between 1905 and 1910 and for the Bureau of Mines since that time.

Professor Fernald is a vice president of the American Society of Mechanical Engineers, and was a member of the Gas Power Section in 1911 and the Philadelphia Section from 1915 to 1916. He is also a member of the Society for the Promotion of Engineering Education, the American Society for Testing Materials, the Franklin Institute, the Philadelphia Chamber of Commerce, Sigma Xi, Phi Kappa Phi and the Engineers' Club.

New Wayne Gravity Oil Filter

The illustration shows the details of an oil filter manufactured by the Wayne Oil Tank and Pump Co., of Fort Wayne, Ind. The filter is adapted to handle continuously large volumes of oil in which quantities of



NEW WAYNE GRAVITY FILTER

free and entrained water and the usual sediment are contained. The water and much of the sediment are removed by a tray system, in a precipitation compartment, so that the work of the filtering medium is reduced. Operation of the new filter, which is of the gravity type, is as follows: Dirty oil enters the filter cabinet through a brass-wire screen, passes to the heating compartment, thence through the precipitating chamber, and from there to the filter units, from which it enters the clean-oil compartment.

Coarse impurities are removed from the dirty oil as it enters the filter by means of the brass screen. The oil then passes downward and thence laterally over the heating coils, which raises its temperature to 180 deg. F. It then passes through a precipitation chamber filled with shallow trays arranged in multiple to give large area and a comparatively long period of time for a given volume of oil to pass, and permits much of the impurities contained in the oil to be deposited on the tray. Most of the water contained in the dirty oil is separated from it as it passes over the heating coils and descends to the bottom of the dirty-oil tank. The rest settles from the oil in its travel over the precipitation trays, an outlet connecting each tray to the bottom of the dirty-oil chamber. For the removal of this water a sealed automatic overflow is provided.

From the precipitation chamber the oil passes through the filter-unit header, on which are mounted two or more cloth filter units which remove the slime and impurities that have not already been precipitated. The filter cloth is made up in the form of a conical tube 4 in. in diameter at one end and 15 in. at the other. The small end of the tube is banded to the center post of the container basket and the body of the tube is made up into vertical sections by drawing it back and forth over a series of concentric cylinders made of galvanized wire screens and of uniform length, each cylinder being larger in diameter than the preceding one. The cloth tube is banded to the inside of the shell of the container basket, which has a leaktight cover held on by screws.

Oil rises through the central tube of the basket and passes downward between the cylinders and horizontally through the filtering cloth. All dirt taken from the oil is retained in the cloth until it is removed for cleaning. Both the filter post and the basket are provided with valves, the stems of which engage when the unit is in place, allowing a free passage of oil and the automatic closing of the valves when the unit is removed for cleaning. The entire unit is placed in an open-top receptacle which allows it to be immersed in oil, thereby maintaining a constant head over its whole surface. The flow of the oil to any particular filtering unit may be shut off if desired by means of an angle valve at the front and exterior to the cabinet, so that if the flow of oil to the filter is slow, one or more sections may be held in reserve.

Cleaning may be done without removing the oil. The precipitation trays are cleaned in place one at a time with hose and water. The dirt on the tray passes to the bottom of the dirty-oil compartment, from which it is conducted to the sewer.

To clean the cloth filter units, they may be lifted from their supporting receptacles, as there are no connections to break. The dirt is deposited on the inside of the units. This type of filter is built for capacities ranging from 2 to 600 gal. per hour.

A resolution was recently introduced in Congress providing for an appropriation of $250,000 to be used to investigate the possibilities of a suitable substitute for gasoline. This money was to be used by the Bureau of Chemistry of the Department of Agriculture. The scarcity of gasoline and the threatened exhaustion of this indispensable fuel in the near future is causing much concern.

The "Africa," announced to be the largest Diesel-engine driven ship in the world, has been launched at Copenhagen. This vessel has a displacement of 14,000 tons, her engines develop 4,500 hp., and all the auxiliaries are electrically driven.

EDITORIALS

The Federated American Engineers

JUNE third and fourth were epoch-making days in the history of American Engineering. On those dates one hundred and twenty-three representatives of sixty-one engineering societies met at Washington and instituted an organization through which the united engineering talent of the country can function for the service of the public and the progress of the profession.

The meeting resulted in a federation of existing societies along the lines laid out by the Joint Conference Committee of the Four Founder Societies rather than in the founding of a new national organization of individual members. One may become a part of it only as a member of one of its constituent societies. Any society of the engineering or allied professions the chief object of which is the advancement of the knowledge and practice of engineering or the application of the allied sciences, which is not organized for commercial purposes and which has at least one hundred members, is eligible for membership. The constituent societies elect representatives to the American Engineering Council, which will meet annually. An executive board is provided, consisting of the six elected officers of the National Council and twenty-four members selected by the group of National societies and the group of state, regional and local societies in the ratio of the combined representation in the National Council of the national societies on the one hand and of the state, regional and local societies on the other.

The Executive Board appoints an executive officer, who serves both the National Council and the Board as secretary. A chart of the organization will be found on page 979, and an account of the organizing conference on page 978. The present Engineering Council is charged with arranging for the first convention of the new National Council and the launching of the federation.

The stage is now set, the program prepared in which the engineer is to take a larger part. Not a more active part, for his has always been the working rôle, but more prominence given to his part. Less work behind the scenes and in the supporting cast and more of the headlines. The engineer has been trained and used to think and do rather than talk. He has been content to be the servant of the administrator at a price. The work of many departments of the public is done by engineers of whom nobody ever hears, under the management of political appointees whose pictures and utterances fill the public prints. The problems of the Government are largely engineering, but one must search far for members of the profession in the lists of state and national legislators. The engineer has now become possessed of a sense of class consciousness, and through more assertiveness upon his part and the cultivation of a keener appreciation on the part of the public of the part which he is playing, hopes to win a more commanding position.

And this can be done both for the individual and the profession by organization and co-operation. It is hoped that there will soon be in every important community a society of engineers that will bring the united engineering thought and experience of its members to bear upon local problems in which engineering is involved. This will furnish the avenue for the engineer to obtain recognition in his own city and encourage and incite his interest in public affairs. The strong, gifted and dominant men in the local societies will be sent as representatives to the National Council and become involved in the wider and larger problems of the country and of the profession, while the activities of the Federated American Societies will result in real service to the public, earning recognition for the profession and for the individuals who have contributed of their time and talent to its accomplishment.

The success of the new organization will depend upon the interest that is taken in it by the rank and file. A select body of higher lights appointed to a council in which the ordinary member feels that he has as little a part as he has in Congress, and then forgotten, will have little chance. They must be backed by a large and sympathetic constituency and with means proportionate to the dignity of the profession that they represent. It is to be hoped that every society, club and organization eligible to join the federation will do so, and that every engineer by joining such a club or society will become identified with the Federated American Societies and take an active part in the work which they are trying to accomplish.

Boiler and Stoker Definitions

HE WHO undertakes to write a definition invites trouble. For a long time the current definitions of a valve would have applied equally well to a door. Lord Kelvin, asked to define entropy, replied that it was a poor name for *it*.

A conference committee of the American Boiler Manufacturers' Association and the Stoker Manufacturers' Association has evolved a series of definitions of terms employed by their member companies. These are printed on page 984. A boiler is defined as a metal vessel, capable of withstanding pressure and serving the purpose of transmitting heat, usually produced by the combustion of fuel, to a liquid contained in the vessel. This is equally applicable to heaters, economizers, evaporators and stills. The elliptical clause, "usually produced by the combustion of fuel," seems to be redundant, for it does not make the definition any less inclusive, and it is difficult if not impossible to conceive of a case in which the heat applied to a boiler of any sort is not directly or indirectly so produced.

The furnace arch is *designed* or *intended* to "aid combustion," but if the proposed definition holds there are some furnace arches that fall outside of its literal interpretation.

Draft is defined as "a difference in pressure, *due to a difference in gas density*, which tends to cause a flow of gas from the region of higher pressure to that of lower pressure," but induced draft and forced draft are

defined as draft "*produced by mechanical means.*" It would seem that the definition of the general term would not be too inclusive if the portion in italics were elided, and the idea of the production of flow or pressure by difference in density be incorporated with the definition of natural draft, in which case this difference is due to temperature difference and not to the pressure, of which a comprehensive interpretation of the definition as proposed would require it to be considered the cause.

The Dawn of a New Day

WHEN in opening the forty-third convention of the National Electric Light Association at Pasadena, California, President Russell H. Ballard said that "the kind of public ownership that brings results is ownership by the public at large in the stocks and bonds of their local regulated utility companies," he very clearly indicated what promises to be the solution of the question of publicly owned versus privately owned public utilities. We have passed through an era of privately owned unregulated utilities, and the outcome was not a very successful one. Municipally owned utilities have been tried and with few exceptions have been found wanting. Past experiences with government regulated utilities, owned by a comparatively few stockholders also have their shortcomings. It has been definitely demonstrated that improper regulation is as bad as, if not worse than, no regulation.

In the operation of every public utility there are three interests to be served—the public, the financial and the utility itself. Past experience has shown that it is poor business to serve one of these at the expense of the others. Only when all three get a square deal can success be assured. One of the best ways to bring about a common interest is local financing. Of course this makes it more imperative than ever before that the utilities be intelligently regulated. Such an arrangement forms, as Mr. Ballard has expressed it, "a partnership which leads to complete understanding and cooperative effort in development and retains in the management and operation of the utilities those trained by long experience to perform the task."

How Much Coal Have You?

HOW serious is the coal shortage situation? Is it as bad as common talk says it is? Is it worse? Who knows?

These are the questions the Geological Survey will soon try to answer. The Director has a list of coal consumers to whom a questionnaire will be mailed. The purpose is to arrive at the approximate truth about coal stock, available coal on hand at the consumers' plants and storage piles. Doubtless some good use can be made of the information after it is compiled. Consumers can help considerably by sending in the answered questionnaire without delay.

Just what real good will be accomplished we do not know. What will be done about it if the inventory shows much or little on hand we have not been told. If it can be made to produce more coal, transport coal faster and in greater volume for domestic (American) use, then by all means spend the money necessary to find out how much is in stock. But will this be accomplished? Conditions do not seem to warrant encouragement that it will.

We believe Europe should have every ounce of coal it needs. We believe America should be generous in exporting the much-needed fuel to those in the war-stricken, famine-ravished lands abroad. But all this provided we do not ourselves get into a serious economic condition in trying to relieve Europe. How much coal, the best of America's best coal, can we afford, can we dare, to let go to Europe? Who knows? Who is trying to find out? No one, as far as we can learn. The Geological Survey issues, periodically, statements telling how much coal was exported in a given interval. But if it told that ninety per cent of that mined in the same interval had gone, it could not do more than that—just tell about it. Neither the Geological Survey nor any other government agency has any authority to say how much of our total may or may not go.

The United States of America is today bidding against Europe for the coal of the United States of America. The seacoast coal piers are working as they never in all their history worked—to load ships bound for Europe.

American railroads may be taking considerably more coal than necessary for current and ordinary storage use. There is likely a shortage of coal cars. Let something be done about all of these; but begin now to determine how seriously we are to be affected if coal continues to Europe in unrestricted flow.

Waterpower Bill on the Rocks

JUST when the country's rejoicing over the passage of the water power bill by both Houses was at its highest, news came that President Wilson, by failure to sign it before Congress adjourned, vetoed the measure. The passage of the bill by both Houses is the climax to twenty years of effort to get the measure through Congress.

The nearest to an official statement that comes from Washington was made informally by Secretary Tumulty, who announced that Secretary Payne of the Interior Department was vigorously opposed to the bill. Later, Mr. Tumulty said that the President had received this measure and others too late to permit of final consideration and favorable action *in view of a serious difference of opinion which had developed.*

The bill went to the President in the middle of the week of the adjournment of Congress, and Congress adjourned Saturday, June fifth. On the Thursday preceding it was referred to the Secretaries of War, Interior and Agriculture, who, under the terms of the bill, were to have constituted a Federal power commission. All three secretaries reported to the President before Saturday, June fifth. Mr. Tumulty's statement clearly implies that the Secretary of the Interior recommended against the bill. But the latter was not alone. Barely a week before passage of the bill, as late as the time of the conference report to the Senate, Senators Lenroot, King and Norris pointed out objectionable features. Secretary Payne is known to be opposed to the bill on the ground that it endangers the beauties of national parks and reservations. The Senators mentioned seem afraid of the power the bill vests in the committee it creates. With the pocket veto a reality, the whole subject begins anew.

With the information now at hand and upon which to base opinion, it seems unfortunate that the President failed to sign the bill.

CORRESPONDENCE

A Transformer-Loss Eliminator

There are doubtless many plants that do not operate continuously, but which are of such size as to warrant disconnecting the main transformers so as to eliminate the dissipation of current as transformer losses, even though a small amount of current may be needed at all times. In order to accomplish this result I once used the method described and illustrated herewith while at an electrically driven pumping station. The service required was that of operating at full capacity for about one-half hour once during each 24 hours and also that of a stand-by plant subject to full load at from one to two minutes' notice.

The size of the plant and the rate per kilowatt-hour ran the transformer energizing losses up to about ten dollars per day. Therefore the 220-volt service, as shown by the sketch, was installed to reduce this loss charge to a minimum.

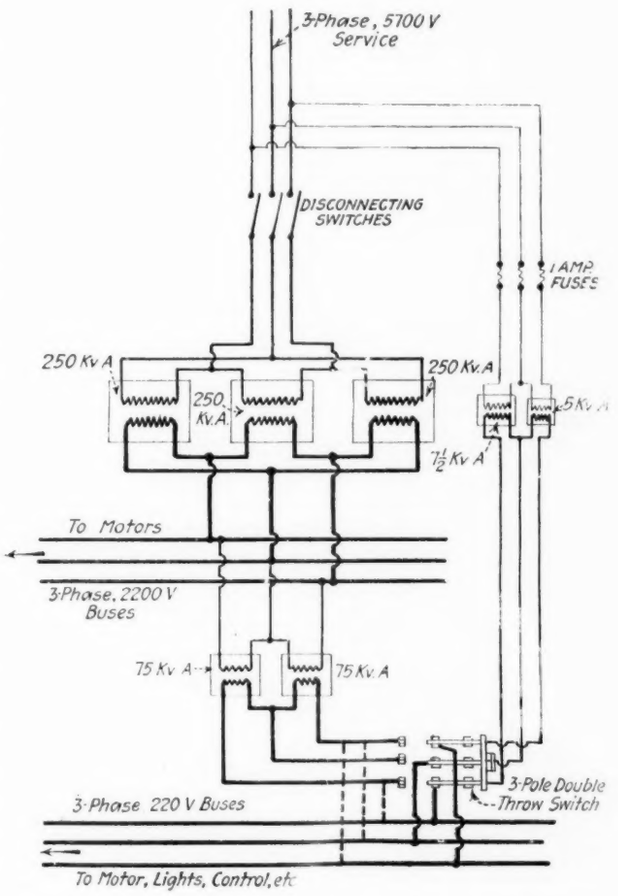
The potential supplied at the disconnecting switches was 5,700-volt, 3-phase, which was transformed to 2,200 volts, at which voltage over 90 per cent of the power was supplied directly to the main motors, only a small quantity being further transformed to 220 volts for operating several small motors, lighting service, remote control, etc. During non-pumping periods the only current needed was for operating one 7½-hp. motor and a few hundred watts of lighting load. This plant operated with this "economizer" in use about 23 hours a day for over 18 months, thereby paying for the effort of its installation many times.

The auxiliary 220-volt service was installed without any additional expense, as there happened to be a 7½- and a 5-kw. transformer, also a three-pole, 300-ampere, single-throw switch at the plant which were not in use. To this switch was added a set of about 60-ampere home-made clips to make it double-throw. The switch was then mounted on an oak plank, painted black to correspond with the slate panels. This plank made a good 220-volt mounting. The labor for making up this layout should not be called a charge, as the men had to be on duty anyway.

The only switch operating necessary to put this economizer in service was to throw the 220-volt double-throw switch from the 75-kw. feed side to the auxiliary feed side and open any two of the 5,700-volt disconnecting switches and vice versa.

It was suggested by one of the electricians who worked on the installation that the double-throw switch be dispensed with and that the auxiliary transformer secondaries be connected to the 220-volt bus at all times, thus allowing the small transformers to float on the line and take their share of the whole load with the main transformers.

The impossibility of doing this was proved by trial for his interest, as it blew the one-ampere, 5,700-volt fuses, this of course being caused by the phase-angu-



WIRING OF THE AUXILIARY TRANSFORMER SERVICE

larity displacement due to the double transformation of the main service and the single transformation of the auxiliary supply.

The 5,700-volt fuse blocks used were made from ¼ x 1 x 7-in. fiber and two ¼-in. stove bolts with double nuts and washers. These fuses were suspended by the feed wires near the transformers and had no rigid support.

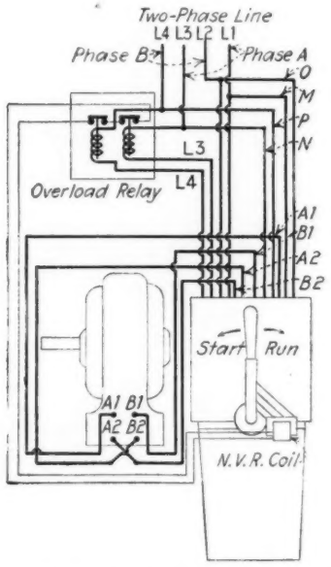
R. W. HARVEY.

Kingston, N. Y.

Induction-Motor Trouble and How It Was Remedied

Quite often difficulties reported as being experienced with new apparatus furnished by electrical manufacturers and installed by customers themselves, prove upon investigation not to have been caused by defects; and improper performance or no performance at all is due entirely to the incorrect installation or wiring up of the apparatus.

Many such instances have come to the writer's attention during several years of road work, and one in-



WIRING DIAGRAM OF COMPENSATOR AND TWO-PHASE MOTOR, "A2" AND "B2" LEADS CROSSED

stance in particular comes to mind which shows how easily the customer can be led to believe that he has received a defective piece of apparatus.

In this case the customer had purchased two motor-generator sets for operating elevators and furnishing power for a number of motors in an office building. The motors were 440-volt two-phase 60-cycle squirrel-cage machines directly connected on a common bedplate to 250-volt direct-current generators of the interpole type. The usual auto-starter, with overload relay and no-voltage release, was supplied for starting, which makes about the most simple class of installation that a wireman has to contend with.

A few days after the apparatus arrived at its destination, the district office of the manufacturer received a telegram from the customer saying that one of the motors was incorrectly wound and would not run; and requested that an engineer be sent immediately to investigate the trouble. The detail to leave on the first train fell to my lot.

Within about five minutes after reaching the job it was discovered that the man who wired up the motor had connected one of the *A* phase leads from the auto-starter to a *B* phase terminal on the motor, and vice versa, as shown in the figure. The two-phase motor had two separate non-interconnected windings and it was therefore impossible to get any response from the motor connected as in the diagram. As is obvious from the figure, all that was necessary to correct this trouble was to interchange the leads connected to the terminals *A2* and *B2* on the motor. After doing so, the motor was found to start up and carry its load in an entirely satisfactory manner. This simple error compelled me to take a 28-hour ride on a railway train, when the wiremen who installed the work could have discovered the trouble if they had taken the time to check their work.

K. A. REED.

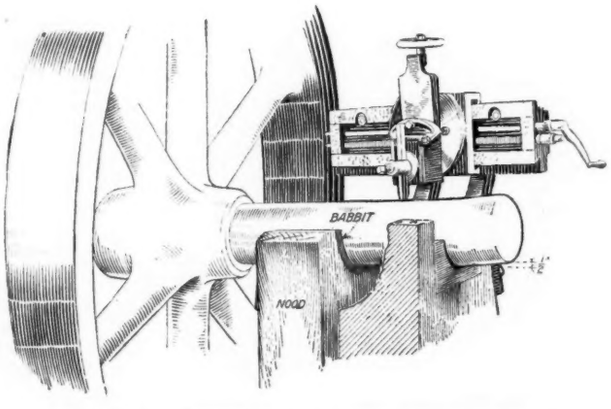
New York City.

Truing a Bent Crankshaft on a Cross-Compound Engine

The electric company of our city has as part of its equipment a cross-compound engine, which is used only when the load is unusually heavy or in case of emergency.

Such was the case not long ago, and the engine was started, but something happened on the low-pressure side (probably water entered the cylinder), and the engine came to a sudden stop and in so doing bent the crankshaft, which was 10 ft. long, 10 in. in diameter between the bearings and 8 in. at the bearings. It carries a 30-ft. diameter by 4-ft. rim flywheel. The engine was badly needed and it was a case of getting a new shaft, which would take a long time, or making repairs on the damaged one. To straighten it was out of the question.

The damage was repaired as follows: As the shaft was bent in the bearing, I removed the crank disc and put in a temporary bearing between the flywheel and the bent end. The quarter boxes were then removed, leaving the shaft to run in the temporary bearing. Next, a tool for turning off the bent part was rigged up; the cross-rail of a small planer was strapped to the engine bed about as shown in the illustration. The engine was then started, running from the high-pressure cylinder, and the bearing part



PLANER CROSSHEAD WAS USED TO TRUE BENT CRANKSHAFT

of the shaft was turned until it was true. Next, the outer end was turned for the crank disc until it was likewise true. The quarter boxes were then rebabbitted to fit the smaller diameter of the crankshaft, after which a sleeve was machined to fit on the end of shaft in order that the crank disc could again be pressed on.

This completed the work, which was entirely satisfactory as to cost and time. The job required 80 hours for one man from the shop; the electric company furnishing helpers from its regular operating crew.

H. E. LARSEN.

Janesville, Wis.

A Proposed Improvement in the Steam-Engine Cycle

The diagram represents a device to save the latent heat in the exhaust from a steam engine. The present system of producing power in steam plants is notoriously wasteful, principally on account of the great amount of heat thrown away in the exhaust steam.

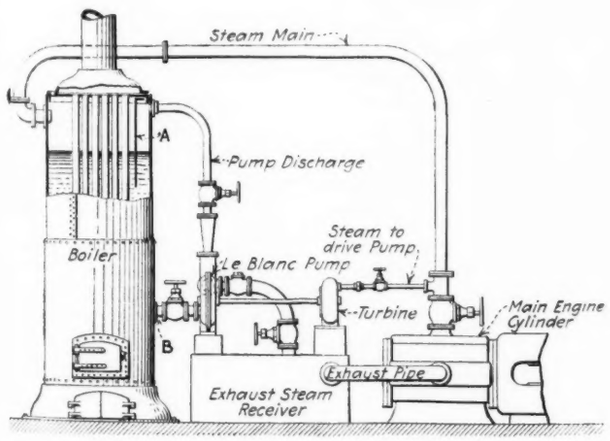
The boiler shown diagrammatically has no unusual features except a baffle or partition *A* in the steam space and a connection *B* to the water space. Steam is supplied to the engine in the usual way, but the exhaust is delivered to the *exhaust steam receiver* instead of to the atmosphere or a condenser. A Le Blanc hurling-water pump takes the steam from this receiver, compresses it and delivers it to the boiler, drawing its circulating water from the boiler itself. This circulating water, being drawn from the boiler and delivered back to the boiler, represents no gain or loss, except that due to radiation and friction in passing through the pump, which may be reduced to a negligible amount.

The value of the device lies in the return of the exhaust steam to the boiler in practically the same condition as when exhausted from the engine. Thus the heat usually carried away in the cooling water is returned to the boiler. The idea that exhaust steam must be condensed before being returned to the boiler is so general that everybody accepts it as a necessary evil. There is, however, nothing impossible in pumping steam instead of water by the use of hurling-water pumps similar to the Le Blanc.

ALFRED COCHRAN.

New York City.

[Mr. Cochran's scheme is in violation of the fundamental thermodynamic principle that some heat must be

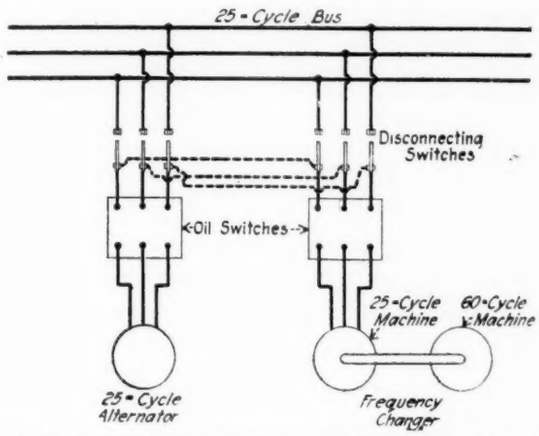


ARRANGEMENT DESIGNED TO SAVE THE LATENT HEAT IN A STEAM ENGINE EXHAUST

rejected by any heat engine unless it can expand its working fluid down to a temperature of absolute zero. Keeping in mind that the value of this device is that all or practically all the heat in the exhaust steam is returned to the boiler, its success depends on the amount of work necessary to compress the steam from exhaust pressure and quality to boiler conditions. If both the engine and compressor could operate without gain of heat from, or loss of heat to, outside bodies, the power required by the latter would be just equal to that developed by the former. The actual engine, however, will develop less power than the ideal non-conducting engine, while the hurling-water pump will require more power than a theoretical compressor. In other words, if the engine is to do more work than the compressor requires, the exhaust steam must be reduced in volume *before* being compressed. The only way to reduce the volume at constant pressure is to reject heat. Therefore, the rejection of heat is necessary for the production of power by a heat engine.—Editor.]

Starting a Frequency Changer

We have a 2,300-volt 60-cycle, 13,200-volt 25-cycle 1,500-kva. frequency-changer set which has always given trouble in starting. There is a 100-kw. 125-volt



CONNECTIONS FOR STARTING FREQUENCY CHANGER

direct-current motor on the shaft for starting purposes, and this motor is connected to the exciter bus, but the necessary starting torque is so large that it requires practically the entire exciter capacity of the station to start the frequency changer, and if started at any time except when the station load is low it would cause an interruption to service. For this reason the frequency changer was shut down only when absolutely necessary; during one period it ran continuously for nearly nine months. However, it became desirable to shut down the set every night, and in order to prevent interruptions to service, the following method of starting was adopted:

The leads from the 25-cycle side of the frequency changer are connected to the bus at a point close to the leads of a 2,000-kw. 25-cycle turbo-alternator, the distance between the disconnecting switches of the two machines being about three feet. When the frequency changer is to be started, the alternator is shut down, if running, the disconnecting switches of the two machines are then opened and jumpers, as indicated by the dotted lines in the figure, are run between the machine sides of these switches, which is a simple matter as they are close together. The oil switches are then closed, both machines excited, and steam admitted to the turbine of the alternator. Since the machines are electrically tied together, they come up to speed together and the frequency changer is synchronized on the 60-cycle bus, after which the oil switches on the 25-cycle side are opened and the disconnects closed. The jumpers between the disconnects of the 25-cycle alternator and the frequency changer are left on except when work is being done on one of the oil switches, since these jumpers do not interfere with the normal operation of the machines.

Allentown, Pa. E. W. MIDDLETON.

Three Power-Plant Leaks That Waste Coal

As near as I can deduce, George H. Smith, on page 627 of the April 20 issue, figured correctly, but why is he feeding water into his boilers at 120 deg. and at the same time allowing steam traps to blow the quivalent of good coal away? Why does he not carry the trap returns back to the boilers so that the loss will balance itself to a great degree?

I recollect the instance of a plant that was operated by a new chief engineer. The traps were of an ancient type and more or less leaky. The chief figured the losses and decided that new traps would be a good investment. He specified and received modern traps, but the saving failed to materialize, as the traps all discharged into a common line and returned to a feed-water tank. The temperature of the water in this tank never reached the boiling point, therefore no steam was actually lost, and of course no fuel was saved by the installation of the new traps.

His failure to make a saving put the new chief in a poor light, and a breach opened between his employer and himself which finally terminated in his resignation. He figured correctly, provided the returns from the old traps had been thrown away.

I believe that it is a wise practice to use a small trap where it is possible, and to let it dump often on the maximum demand so as to decrease the chance of leakage.

My experience has convinced me that insulating material is the best-paying investment of any one thing about the steam plant. C. W. PETERS.

New York City.

Ampere-Turns in Field Coils

In a direct-current motor the field strength depends on the number of ampere-turns. By increasing the number of turns in the field coils the current may be reduced indefinitely without reducing the degree of saturation.

Now then, the statement has been made that "theoretically no current is required for exciting the fields of a direct-current motor." Is this assumption correct or not? EDWIN C. HUTH.

Cincinnati, Ohio.

[Taking a given coil with a fixed voltage E applied to it, the ampere-turns $IT = \frac{E\ circ.mils}{L}$, where L equals the mean length of one turn in inches. Now if the circular mils are halved and we assume that the mean length L of one turn remains constant, then the voltage E will have to be doubled to maintain the ampere-turns constant. Therefore, the product of the volts and amperes—that is, the watts—will be the same in both cases. This is what is wrong with the foregoing assumption. It is based on current only and not on watts, the product of volts and amperes. Although the current necessary to produce a given number of ampere-turns in a coil of fixed dimensions may be reduced in direct proportion to the reduction in circular-mil cross-sectional area of the copper, the voltage must be increased proportionately to set up the current through the coil, consequently the watts remain constant. Whether the coil has 100 turns with 1 ampere and 100 volts applied or 10,000 turns with 0.01 ampere and 10,000 volts applied, the result is 100 ampere-turns and 100 watts in either case. Since in a given motor the voltage E is fixed by the circuit it is designed to operate on, the size of the wire in the field coils to produce a given number of ampere-turns is also fixed by the winding space, the watts that the coil will dissipate without excessive heating, etc. The effect of insulation has been neglected in the foregoing.

Considering the question from a purely theoretical standpoint, if the cross-section of the wire in the coil and the applied voltage are held constant and the number of turns increased, the current will be, if the mean length of one turn could be held constant, reduced in direct proportion to the number of turns. But even if this was carried to infinity, the current would not be zero. Furthermore, the resistance of the coil increases faster than the number of turns on account of the length of the mean turn increasing with the size of the coil. In addition the coil would soon reach such proportions that the outside ampere-turns would have very little or no effect upon the core in the center of the coil.—Editor.]

Prolonging the Life of Condenser Tubes

In *Power* for April 13, 1920, page 588, Julian N. Walton states that the use of metallic packing on condenser tubes is advantageous because it bonds the tube electrically to the tube sheet, and thereby prevents electrochemical decomposition of the tubes. I believe that Mr. Walton is wrong in this matter.

If we immerse two electrodes in a suitable electrolyte, there will be no galvanic action if the electrodes are not electrically connected outside the solution. As soon as an outside connection is established, galvanic action will begin.

If, therefore, it were true, as Mr. Walton states, that fiber and fabric packings insulate the tubes from the tube sheets, these should be an ideal preventive of galvanic action. But such packings do not insulate the tubes, because there is direct metallic contact between the tubes and the tube sheet, and also a metallic connection through the ferrule, which is often in contact with the tube.

By the same token, Mr. Walton's metallic packing, being presumably a good conductor, could do nothing to reduce electrolysis, although it would probably not make matters any worse than they are.

Detroit, Mich. C. HAROLD BERRY.

Proposed National Engineer's License Law

Mr. Peters, on page 434 of the March 16 issue, suggests that when his proposed National license law goes into effect, engineers be given a special license without examination.

Why should not engineers holding first- and second-class licenses be given the same license they now hold? A man who obtains a first- or second-class license permitting him to operate in Massachusetts is capable of running a plant in Ohio or any other state. Then, under a National law, when a man wants to change his position from one state to another, it will not be necessary to pass another examination. H. A. BLANDFORD.

North Adams, Mass.

INQUIRIES OF GENERAL INTEREST

Grease More Dangerous to Burning New Boilers—Are new boiler tubes more likely to be burned from deposit of oil or grease than old ones? G. T.

It has been found that clean new flues and other heating surfaces are more affected by oil than old surfaces, especially where the latter are coated with an appreciable amount of scale. Many cases of burning of new boilers have been known where the thickness of the oil or grease coating has probably been less than one-thousandth of an inch.

Advantages of Multi-Pump Valves—Why are the water ends of steam pumps provided with a number of valves in place of a single large valve for each suction and discharge chamber? C. T.

A number of valves are not likely to be seated absolutely at the same time, and less shock is thereby imparted to the valve deck than when one large and heavy valve comes down on its seat. In addition to the advantage of smoother operation, several smaller valves are easier to construct, replace and repair than a single large valve of the same capacity.

Providing Against Pitting o Boiler—What steps should be taken if a boiler plate is found to be pitted? J. B.

When pitting is discovered, it should be determined by competent inspection whether the corrosion sufficiently endangers the safety of the boiler to require renewal of the plate, or the highest working pressure that can be carried with safety. When use of the boiler is to be continued, such inspections and determinations should be made at frequent intervals, and to arrest the pitting the feed water should receive suitable treatment for neutralizing the corrosive action of the impurities, as revealed by chemical analysis.

Designations of Boiler-Feed Waters—What proportion of scale-forming substances is allowable for good boiler-feed water? R. E.

The term "good" as applied to feed waters is only relative. The following designations are generally used, based on the number of grains of scale-forming ingredients per gallon of the feed water:

Less than 8 gr. per gal.—Very good.
From 8 to 12 gr. per gal.—Good.
From 12 to 15 gr. per gal.—Fair.
From 15 to 20 gr. per gal.—Poor.

When there is over 20 gr. of scale-forming materials to the gallon, the water should not be used unless first purified.

Material for Reinforcing Concrete—Cannot old hoisting cable be used to good advantage for reinforcing a concrete foundation for an engine and direct-connected generator? W. A. T.

Reinforcing material for concrete is principally of value in resistance of initial tensile and shearing stresses, for which purpose wire cable would be of little advantage in prevention of cracks or for maintaining the solidity of a foundation. Cable would be useful mainly for preventing sections of the concrete from falling apart after fracture had occurred and, for that purpose might be useful for incorporation in concrete work where permanent monolithic construction is not imperative.

Vacuum Referred to Standard 30 Barometer—What is the vacuum referred to a 30-in. barometer if the height of a mercury vacuum gage is 26.5 in. with a temperature of 80 deg. F. and the actual barometer reading is 29.3 in. and temperature 60 deg. F.? W. L. G.

Standard barometric pressure for comparison is usually taken as 30 in. for 32 deg. F. Allowing 0.0001 for the coefficient of expansion of mercury per degree F. of temperature, the reading of the vacuum gage corrected to the standard temperature would be

$$26.5\ [1-0.0001(80-32)] = 24.37 \text{ in.}$$

and for the barometer

$$29.3\ [1-0.0001(60-32)] = 29.21$$

Hence the absolute pressure in inches of mercury at the temperature of 32 deg. F. would be 29.21–24.37 = 4.84 in., and the vacuum referred to 30 in. barometer at 32 deg. F. would be 30–4.84 = 25.16 in.

Size of Pipe Line and Power for Pumping—What size of iron pipe line 1,200 ft. long would be suitable for delivery of 15 gal. of water per minute at 30-lb. pressure, pumped from a lake to an elevation of 85 ft? What would be the pressure on the pump from the line when not running, if the pump is placed 5 ft. above the lake, and what should be the horsepower of a motor for operation of the pump? W. P. O.

With the discharge end of the line open to atmospheric pressure and the line filled with water, the static, or standing, pressure in the pipe at the pump would be $(85 - 5) \times 0.433 = 34.6$ lb. per sq.in.

Pumpage at the rate of 15 gal. per minute with a total lift of 85 ft. and discharge pressure of 30 lb. per sq.in., without allowance for power to overcome pipe friction, would require $\dfrac{[30 + (85 \times 0.433)]\ 15 \times 231}{12 \times 33{,}000}$ = about 0.6 net or water horsepower, and with a pump efficiency of 50 per cent, the required power would be $0.6 \div 0.50 = 1.2$ hp., neglecting pipe friction. For discharging 15 gal. per minute through 1,200 ft. of smooth, clean 1¼-in. iron or steel pipe, the pressure required for overcoming friction would be about 42 lb. per sq.in.; for 1½-in. pipe, about 15 lb. per sq.in.; and for 2-in. pipe, about 6 lb. per sq.in. With 50 per cent pump efficiency, each pound pressure, with discharge at the rate of 15 gal. per minute, would require $\dfrac{1 \times 15 \times 231}{12 \times 33{,}000 \times 0.50} = 0.0175$ hp. and the total power required using 1¼-in. pipe would be $(0.0175 \times 42) + 1.2 = 1.9$ hp.; using 1½-in. pipe, $(0.0175 \times 15) + 1.2 = 1.5$ hp.; and using 2-in. pipe, $(0.0175 \times 6) + 1.2 = 1.3$ hp. The pressure and consequently the pump friction increases with use of a pipe line on account of an increase of roughness of the bore and reduction of diameter due to scale and corrosion. Therefore it would be advisable to provide a pipe not less than 1½ in. in diameter and a motor of not less capacity than 2 brake horsepower.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. Editor.]

Federated American Engineering Societies

PURSUANT to the call of the Four Founder Societies issued through their Joint Conference Committee, representatives from the following societies met in Washington on June 3 and 4 to organize a national engineering body:

American Association of Engineers.
American Association of Petroleum Geologists.
American Ceramic Society.
American Electric Railway Engineering Association.
American Electro-Chemical Society.
American Institute of Electrical Engineers.
American Institute of Mining and Metallurgical Engineers.
American Railway Engineering Association.
American Society of Agricultural Engineers.
American Society of Civil Engineers.
American Society of Mechanical Engineers.
American Society of Naval Architects and Marine Engineers.
American Society of Refrigerating Engineers.
American Society for Testing Materials.
American Society of Heating and Ventilating Engineers.
American Water Works Association.
Associated Engineering Societies of St. Louis.
Association of Railroad Engineers.
Boston Society of Civil Engineers.
Brooklyn Engineers' Club.
Cleveland Engineering Society.
Colorado Society of Engineers.
Detroit Engineering Society.
Duluth Engineers' Club.
Engineering Council.
Engineers' Club of Baltimore.
Engineers' and Architects' Club of Louisville.
Engineers' Club of Philadelphia.
Engineers' Club of St. Louis.
Engineers' Club of Trenton, N. J.
Engineering Society of Akron, Ohio.
Engineering Society of Eastern New York.
Engineering Society of Buffalo.
Engineers' Society of Pennsylvania.
Engineers' Society of Western Pennsylvania.
Florida Engineering Society.
Grand Rapids Engineering Society.
Illinois Society of Engineers.
Illuminating Engineering Society.
Indiana Engineering Society.
Institute of Radio Engineers.
Iowa Engineering Society.
Kansas Engineering Society.
Los Angeles Joint Technical Society.
Mohawk Valley Engineers' Club.
National Fire Protection Association.
Nashville Engineering Association.
Northeastern Water Works Association.
Oregon Technical Council.
Providence Engineering Society.
San Francisco Joint Council of Engineering Societies.
Scientific Club (Indianapolis).
Society of Automotive Engineers.
Society of Industrial Engineers.
Society for Promotion of Engineering Education.
Society of American Military Engineers.
Taylor Society of New York City.
Technical Club of Dallas.
Topeka Engineers' Club.
Vermont Society of Engineers.
Washington Society of Engineers.

The meeting was called to order in the auditorium of the Cosmos Club at ten o'clock Thursday morning by Richard L. Humphrey, consulting engineer, of Philadelphia, and chairman of the Joint Conference Committee. In his opening address he said that the committee had issued invitations to 110 engineering and allied technical organizations and societies representing an aggregate membership of over 120,000, who under the conditions of the call were entitled to send 184 delegates. "The list," he said, "included all societies, organizations or affiliations, not associations, sections, chapters or branches of national societies, whose chief object is the advancement of the knowledge and practice of engineering and the application of allied sciences, and who are not organized for commercial purposes." There were in attendance delegates representing over 60 per cent of the organizations invited. These delegates, over 70 per cent of those entitled to attend, represented organizations having an aggregate membership of over 100,000, or over 83 per cent of the membership of all the organizations invited.

Calvert Townley, president of the American Institute of Electrical Engineers, was elected chairman, and John C. Hoyt secretary, and the business before the conference was definitely set forth in the following resolutions presented by Major Gardner S. Williams, representing the Grand Rapids, Mich., Engineering Society.

Resolved, That it is the sense of this conference that an organization be created to further the public welfare where technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions, and

Resolved, That it is the sense of the conference that the proper organization should be an organization of societies and affiliations and not of individuals.

These resolutions resulted in considerable discussion, as they brought up the question as to what action would be taken by the American Society of Civil Engineers and by the American Association of Engineers. Although the latter society was strongly opposed to such an organization as described in the second resolution, its delegates at last voted for the resolutions, so as not to obstruct the wishes of an obvious majority of the conference. The roll call on the resolutions showed 119 affirmative and no negative votes.

The organization having been decided upon, Chairman Townley appointed the following committees: Constitution and By-laws, R. L. Humphrey, chairman; Resolutions, Philip N. Moore, chairman; and Program, R. H. Fernald, chairman. Each committee consisted of about twenty-five members.

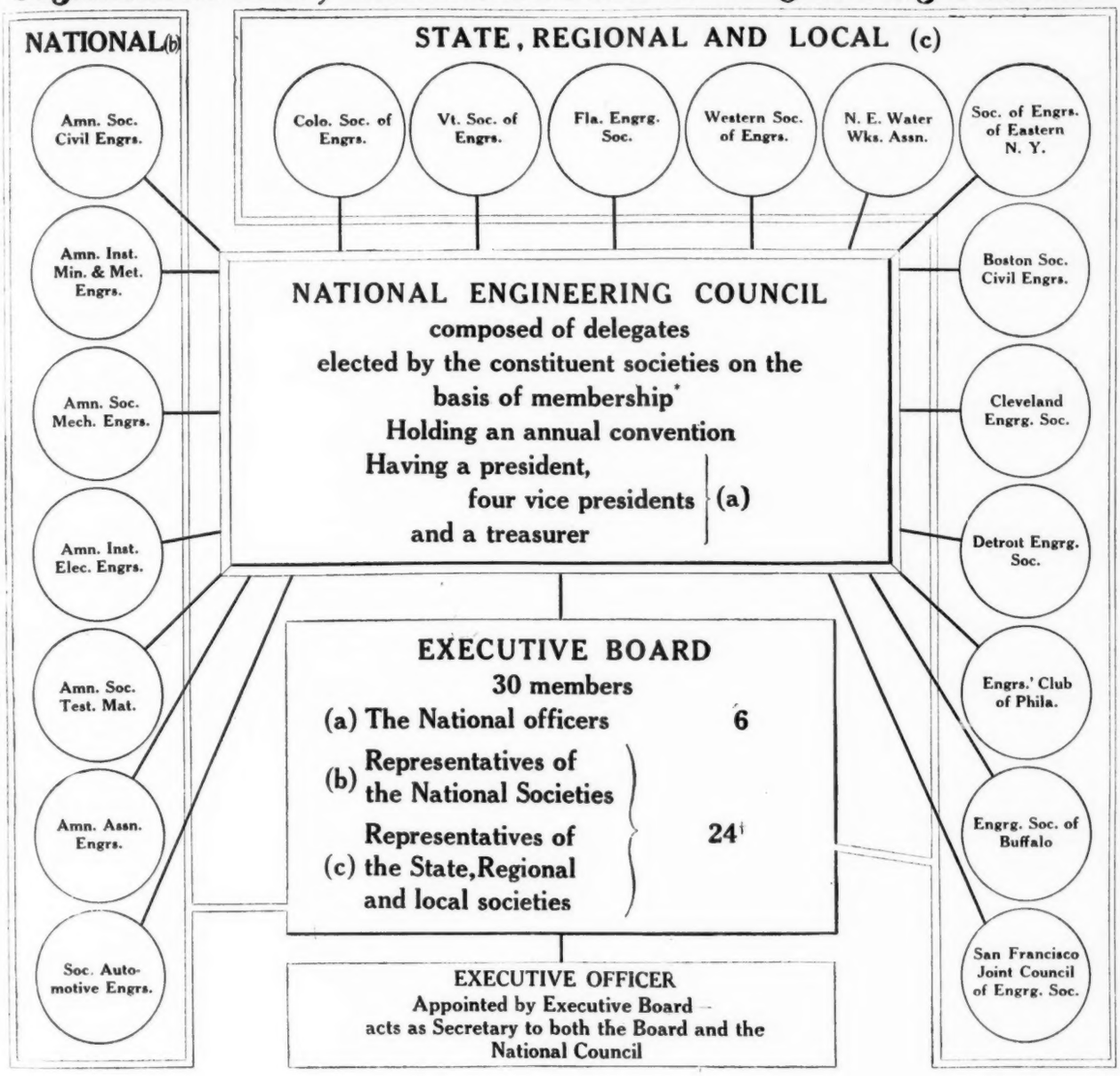
Thursday Afternoon Session

In the afternoon session of Thursday, several formal addresses were delivered on subjects of interest to the delegates. Arthur R. Davis, president of the American Society of Civil Engineers, spoke on the subject "Functions of the Engineer in Public Affairs." Mr. Davis urged a unity of movement among engineers and emphasized the power of such a body as was to be formed by the conference.

He was followed by Philip N. Moore, a past president of the American Institute of Mining and Metallurgical Engineers, who spoke on the same subject. Mr. Moore pointed out that for the first time authorized sanction from the "great dignified old national technical societies" has been given for a body which shall speak for all branches of the engineering profession throughout the land. Some such body has been attempted in Engineering Council, but its limitations have led to the proposal for this new body, which shall be better able to carry on the work. As a member of Engineering Council Mr. Moore asserted that its members were proud of its work, but were ready to see it displaced by a more potent organization for the good of the profession. The nation has grown so large that only by organization can public needs and ideals reach the public ear. Reformers of all kinds have recognized this and by organization have had their views expressed in the form of statutes and constitutional amendment. Engineers must recognize this fact and also that social problems must be met as such and not as mathematical problems. Only by such recognition and organization can engineering service be most fully rendered to the public and engineers have their just voice in the affairs of the nation.

F. H. Newell, past president of the American Association of Engineers, spoke on its form of organization and called attention to the weakness of a confederation form as com-

Organization Chart of the Federated American Engineering Societies


NATIONAL(b)
Amn. Soc. Civil Engrs.
Amn. Inst. Min. & Met. Engrs.
Amn. Soc. Mech. Engrs.
Amn. Inst. Elec. Engrs.
Amn. Soc. Test. Mat.
Amn. Assn. Engrs.
Soc. Automotive Engrs.
STATE, REGIONAL AND LOCAL (c)
Colo. Soc. of Engrs.
Vt. Soc. of Engrs.
Fla. Engrg. Soc.
Western Soc. of Engrs.
N. E. Water Wks. Assn.
Soc. of Engrs. of Eastern N. Y.
Boston Soc. Civil Engrs.
Cleveland Engrg. Soc.
Detroit Engrg. Soc.
Engrs.' Club of Phila.
Engrg. Soc. of Buffalo
San Francisco Joint Council of Engrg. Soc.
NATIONAL ENGINEERING COUNCIL
composed of delegates
elected by the constituent societies on the
basis of membership*
Holding an annual convention
Having a president,
four vice presidents (a)
and a treasurer
EXECUTIVE BOARD
30 members
(a) The National officers 6
(b) Representatives of the National Societies
(c) Representatives of the State, Regional and local societies 24†
EXECUTIVE OFFICER
Appointed by Executive Board —
acts as Secretary to both the Board and the
National Council

The representatives of the group of National Societies on the Executive Board are to be elected or appointed or designated by the National Societies in any way upon which these societies may agree among themselves.

*Representation in the National Council is on the basis of one delegate for 100 to 1000 members and one additional delegate for each additional 1000 or major fraction thereof for national and other societies alike; no society to have more than 20 delegates.

†Representation on the Executive Board is so divided that the representation of the group of national societies (b) bears the same ratio to the representation of the group of state, regional and local societies (c) that the combined representation of the national societies in the Council bears to that of the other societies.

The representatives of the group of state, regional and local societies on the Executive Board to be elected by districts, the boundaries of which are so prescribed as to take account of both membership and area.

State, regional or local societies may be composed of a number of affiliated societies, sections, clubs, etc., but in the determination of their representation no count shall be taken of any organization which is represented individually or through another local, state or regional organization or affiliation.

The societies diagrammed are simply chosen as typical. Not all of those shown have indicated their intentions of joining the federation, and not all of those taking part in the organizing conference are included in the diagram.

pared with the federation form where each individual is a member of the general organization. A man is a citizen of the United States, not because he is a citizen of any one state; in the same sense he must be a member of the all inclusive society not solely because he is a member of a technical or local society. Mr. Newell traced briefly the organization of the American Association of Engineers and pointed out four optional courses of action on the part of the proposed organization toward the A. A. E.

Thomas H. McDonald, chief of the United States Bureau of Public Roads, reviewed the financial aspects of the Federal-aid road program and urged the co-operation of the new engineers' organization in opposing any classification of road building and maintenance as non-essential and therefore not entitled to preferred shipments by rail. William D. Uhler, chief engineer, Pennsylvania State Highway Department, spoke on the economic value of good roads.

Thursday Evening Session

In the Thursday evening session, which was held in the New Willard, Homer L. Ferguson, past president, United States Chamber of Commerce, told the engineers they needed more of the business point of view. He considered engineers lacked one quality of good business men. That missing quality was ability as public speakers.

James H. McGraw, President of the McGraw-Hill Co., Inc., speaking on the subject "Publicity for Engineers," pointed out the engineer's habitual avoidance of publicity which has resulted in the public being conscious of engineers as good servants without seeing them as real leaders upon whose thinking all the necessities and most of the luxuries of life depend. At present, however, the public mind is very receptive to engineering publicity, and the proposed federation of engineering societies should be a powerful factor in accomplishing such publicity. The mediums for publicity for engineers include the newspapers, the general magazines, the technical and industrial press, papers before societies and the public platform. From his own publishing experience Mr. McGraw pointed out the close relations between the engineer, the technical societies and the technical press. The technical press has greatly helped the engineer, and on the other hand the technical press cannot exist without the engineer. The technical societies and the engineering papers are natural partners, and each has its share in the general welfare. There should be no competition between the society publications and the independent press, since although they both serve in the same field, their services are different.

The last address of the evening was by George Otis Smith, Director of the United States Geological Survey, "The Engineer and National Prosperity." Mr. Smith paid a tribute to the engineer as living up to the specifications for good citizenship. In contrast with the lawyer-statesman, who looks backward, the engineer looks forward. He plans for coming events. Because he ever keeps in mind the factor of safety, he will make plans for future prosperity which are safe. The engineer is also constructive. As an illustration, the bridge engineer sees the future need for a larger heavier bridge to replace an old one. He makes his complete design in such a way that the new structure will be ample and safe, and then he erects the new bridge around the old one without interfering with traffic. Thus the engineer in any project builds up the new faster than he tears down the old so that he finally turns over a finished job, a monument to the characteristic engineering habit of seeing the thing through.

Friday Morning Session

On the morning of June 4 the report of the Committee on Constitution and By-laws was presented and, after a lengthy discussion, was approved practically without change. While the form of the document is subjected to editorial revision, it is substantially as follows:

The name of the organization is to be The Federated American Engineering Societies. Its object is stated to be "to further the interests of the public through the use of technical knowledge and engineering experience, and to consider and act upon matters common to the engineering and allied technical professions." The membership is to consist of national, local, state or regional engineering or allied technical organizations and affiliations.

The management is to be vested in a body known as the American Engineering Council and its Executive Board. The Council is to be made up of representatives from organizations on the basis of one representative for a membership of 100 to 1,000 inclusive with one additional representative for each additional 1,000 or major fraction thereof. The officers shall be a president (elected for two years and ineligible for re-election), four vice-presidents (two elected each year for two years), and a treasurer (elected for one year). There is also to be an executive officer, or secretary, appointed by the Executive Board.

The business of the organization shall be conducted by an Executive Board of thirty members, six to be the officers elected by the Council and twenty-four selected, a part by the national societies and the remainder by the local, state or regional organizations according to districts.

The funds for the organization shall be provided by each national society contributing $1.50 per member and each local, state or regional organization $1 per member, annually.

Provision is made for the formation of local affiliations and state councils with specific delimitation of authority between the various bodies.

Vote on Acceptance of Constitution

When the American Association of Engineers delegates were called on to vote on the acceptance of the proposed constitution, their spokesman asked permission to make a statement before announcing their vote. The affirmative vote on the Williams resolutions was cast in order not to appear as obstructionists. When it came to approving the constitution, however, and joining the new organization, the A. A. E. delegates felt they would be giving up their own welfare work as well as contributing about $30,000 annually to the new federation whose work would be much the same as that of their own "going" organization. Therefore they would not obligate their own organization to join the new one. It was maintained, however, that the A. A. E. hoped to co-operate with the new federation. Under the circumstances the American Association of Engineers' delegates requested that they be recorded as "present but not voting."

There were 88 affirmative votes, and none negative, a few of the societies being recorded as "present but not voting" or "absent."

On Friday Leroy K. Sherman, president of the United States Housing Corporation, Washington, D. C., spoke on "Functions of the Engineer in Public Affairs," his address having been postponed from Thursday morning. He stated that it was estimated that over 25 per cent of all engineers are engaged in some sort of public-service work. There are more engineers as employees of the public—municipal, state and national—than employees from all the other professions. The number of engineers in executive positions in public work, however, is comparatively small. This is largely the fault of the engineers themselves as their training deals with things and not with men and they are reluctant to deal with matters outside the strictly technical field of engineering. For the good of the public as well as of engineers the engineering profession must appreciate the human element more and take a larger part in leading public affairs.

Friday Evening Session

In the Friday evening session, several addresses were given, one by Samuel M. Vauclain, president of the Baldwin Locomotive Works. Mr. Vauclain sketched the problems of an industrial executive. The man who has confidence in himself and also in his subordinates is the one who becomes a really great engineering executive. Addresses were also delivered by Robert S. Woodward, president, Carnegie Institute, Washington, and James R. Angell, chairman, National Research Council.

The morning and afternoon sessions were held at the Cosmos Clubhouse, while both evening sessions were at the New Willard Hotel.

At the close of the business session resolutions were adopted:

1. Urging the payment of adequate salaries for the teachers of engineering in our technical institutions in order that adequately trained young engineering talent may be made regularly available.

2. Advocating the immediate adoption of appropriate measures to give effect to the recommendations made to Congress by the commission which recently reported upon a more adequate salary schedule for the engineering and other technical services of the Federal Government.

3. Indorsing the bill which has for some time been under consideration by Congress for the creation of a Department of Public Works.

4. Expressing the appreciation of the Organization Conference of the valuable work of the Engineering Council, especially its offers of assistance in making effective and operative the newly devised plan of organization; and expressing thanks to the Washington Society of Engineers and the Cosmos Club for their courtesy and assistance afforded during the sessions of the Conference.

Pennsylvania Electric Association Holds Harrisburg Meeting

Central-station steam heating was discussed by the Central Geographic Section of the Pennsylvania Electric Association during the morning session of the meeting held June 4, at the Penn Harris Hotel, Harrisburg, Pa., Chairman H. Root Palmer presiding. A paper on the subject was read by W. J. Kline. The author called attention to the effect that the higher price of coal has had in changing the attitude, of even those operating small plants, toward the methods used in power-plant operation. He was of the opinion that the present central-station methods of converting the chemical energy of coal into electrical energy should be changed wherever feasible to utilize as high a percentage of the heat as possible. The greatest loss in converting the chemical energy in the coal into electrical energy is that which is carried away in the circulating water and amounts to somewhere between 57 and 62 per cent of the total heat available for use in the turbine. In the large central stations that are looked upon as the last word in efficiency, there is wasted approximately 60 per cent of the total heat available. Mr. Kline was of the opinion that the greatest opportunity that existed today for fuel saving was in the co-ordination of power generation with the supply of heat. Too much stress has been laid on the cost of producing a kilowatt and not enough on the thermal units used. In the large central stations a kilowatt-hour is produced on 17,000 B.t.u., but in doing so there is wasted several times that amount of heat in the circulating water, where in the isolated plant that has a heating load the 60 per cent being thrown away by the central station is being used.

In discussing the difficulties of operating a district steam-heating system, W. P. Frehsee said that in the last few years he had found that 75 per cent of the trouble calls were from plants that had no supervision. Large bills were due largely to the way the customer operated his plant and the conditions of his heating equipment. He laid considerable stress on the utility working hand in hand with the customer and giving him the proper information for the satisfactory operation of his heating equipment. Mr. Frehsee said that his company was recommending the vapor system on all new work.

F. H. Hobbs said the keynote of steam heating had been struck when it was a service that was sold. There is no reason why steam heating should not receive a rate commensurate with the service rendered.

The discussion brought out that there was a need for a better meter than at present available for measuring the weight of steam supplied for heating. At present the best way is to measure the condensate. However, if it were possible to satisfactorily measure the steam, this would eliminate the losses due to leaks in the customer's heating system. One of the chief troubles experienced with the condensate type of meters is, they are liable to stop unless watched closely. Some of the companies found it necessary to read and inspect the meters every two weeks in order to keep them operating properly.

E. D. Dryfuss called attention to the increasing cost and carcity of natural gas, and said this would result in a demand for other means of heating in the localities now served by natural gas. He said ten-cent gas is about equal to dollar fuel; the price of coal is up to stay and the natural gas is approaching exhaustion, consequently conditions are becoming more favorable for district-steam heating. Mr. Dryfuss emphasized the danger from explosions when using gas with the supply as uncertain as at present.

F. W. Harris told of the excellent results his company had obtained on its heating system by using the extractor type of turbines. He said they had tried steam engines and made up the shortage of exhaust with live steam, but this was not as satisfactory as using bleeder turbines.

At the afternoon session accounting and operating records was the subject discussed. A paper on the "Classifications of Cost Records" was presented by C. Mac C. Breitinger. In his paper the author emphasized the difficulties of meeting the accounting classification required by the public-service commission regulations, saying it was impossible to obtain the cost of each job and that, to make the classification according to the present law considerably increased the cost of keeping public-service utility accounts. The purpose of the paper was to get a consensus of opinion so that some recommendations may be formed to reduce the large amount of expense and clerical work necessary in keeping accounts according to the present classification of the public-service commission.

From the discussion it was apparent that the small companies were having very little difficulty in keeping their accounts according to the public-service commission's classifications, but the chief difficulty was with the larger companies when the system of transmission and distribution became involved. Various suggestions were made for segregating the different charges. With the small companies this was done to a large extent by the men on the job, but in the larger companies the segregating of costs was done by the accounting department.

Short papers on power-station records were presented by J. F. Cole and F. L. Allner. The importance of the station log sheet was emphasized. It was the opinion that this should be so designed and kept that, when complete, it would contain all the information necessary to an intelligent study of plant operation. In addition to the log sheet, other reports are necessary such as semi-monthly inspection reports, trouble reports, etc. Mr. Allner said that in addition to their engineering value station records were of educational and training value to the operating force. He said that in the station at Holtwood, in addition to the log sheet, a logbook was kept in which all events are recorded that may be of interest to the operating force. Furthermore, each operator going off duty is required to leave a one-line diagram of the connections on the system at the time of leaving and sign his name to it. Another feature of plant records at Holtwood is the use of the dictaphone in transmitting all messages. The dictaphone is used to obtain a record of the message given over the telephone and has had a good effect in making the operators use precision in transmitting messages. This system has been in use seven years and has worked out very satisfactorily.

In the discussion on instruments the opinion was expressed that although there was a tendency in many cases to change from indicating to graphic instruments, nevertheless, these instruments are not all that might be expected of them, and not infrequently they give considerable trouble. It was thought better to use graphic instruments for intermittent reading only, cutting the instrument into circuit when it was desired to make the record. Attention was called to one case where a graphic voltmeter, with a paper speed of one inch per minute was used, and cut into the circuit by a quick-acting relay, when the voltage drops a few per cent.

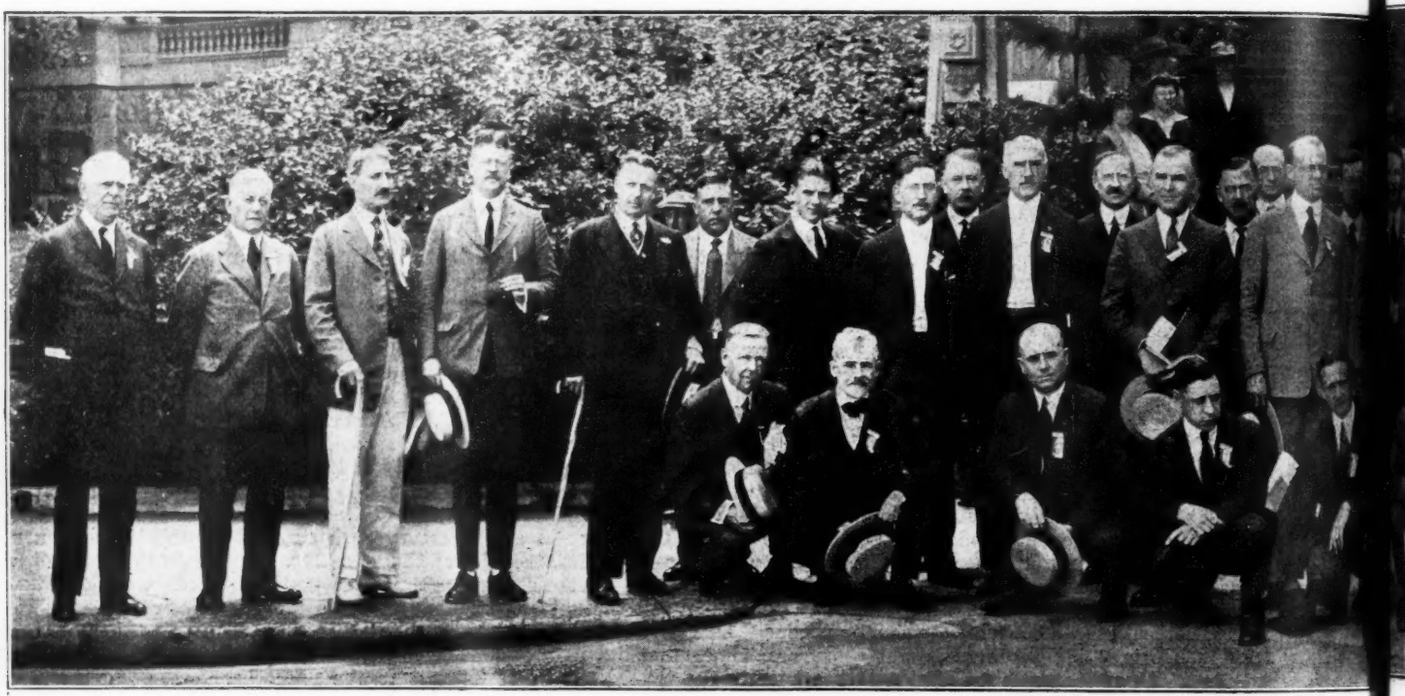
In discussing meter records, F. L. Althouse emphasized the importance of watt-hour meter accuracy by calling attention to the fact that 1 or 2 per cent in the accuracy of meters may amount to as much in revenue as several per cent saving in coal at the plant.

American Boiler Manufacturers' Association

THE thirty-second annual convention of the American Boiler Manufacturers' Association brought together upward of sixty of the members and guests of the association with their ladies, at French Lick Springs. The meetings opened on Monday morning, May 31, with a paper by David Moffat Myers, engineer of the United States Fuel Administration on "Fuel Conservation."

A thorough application of all known and tried methods of fuel conservation in the United States would result in an annual saving of seventy-five to one hundred million tons of coal.

The results of conservation would be a money saving, based on the figure of seventy-five million dollars per annum; the transportation of coal would be reduced to an extent equivalent to 1½ million 50-ton car loads per year; seventy-five thousand of the 750,000 men engaged in mining coal could be taken from the mines and put to work in other fields; locomotive and train crews relieved from coal haulage would be of enormous service in the handling of freight; the labor of firing 75 million tons of coal per year under boilers and in furnaces would be eliminated; fuel conservation would reduce the cost of manufactured articles, and incidentally it would add materially to the life of our coal deposits and the supply of other fuels.



Fuel conservation, if developed to a reasonable extent, would mean a saving of nearly four dollars for each man, woman and child in the United States. Not only would the greatest industrial problem of the age be solved, but we could do our part in supplying markets of other countries.

One important phase of the situation is to learn how to get the best out of existing equipment by means of correct and economical operation.

There is not an industrial plant in the United States where 10 per cent to 30 per cent saving in fuel might not readily be effected by comparatively simple improvements in design and operation. You are all certainly familiar with the tremendous waste in the combustion of fuel under stationary boilers and in locomotive boilers, in the firing of coal, in the cleaning of fires, in the keeping of tight boiler settings, in the prevention of soot and scale on the heating surfaces and in the operation of boilers at their best capacity; in these features waste exists in every plant, and waste which is readily correctible. Prevention of waste is merely a matter of the application of well-known engineering principles.

Then fuel is wasted in the use of steam after its generation. Inefficient types of prime movers, careless maintenance of engines and pumps, ill-advised installations unsuited to the purpose they would fulfill, huge volumes of wasted exhaust steam expelled to the atmosphere, the unnecessary use of live steam from boilers where exhaust steam with proper engineering would fully meet the requirements, badly designed and ill-kept transmission systems—all these contribute their quota to the vast waste of fuel which is taking place in practically every industrial plant in the country. To this list should be added the fact that the average public-service station discharges 80 per cent of all the heat of its steam into the condenser—an irretrievable loss.

Oil is almost an ideal fuel, but owing to its extremely limited supply it should be applied only to very special uses where its natural characteristics are distinctly and specifically in demand, as in naval and certain classes of marine practice and for special industrial processes, etc. Under equally favorable conditions it is true that a somewhat higher thermal efficiency can be obtained with oil than with stoker-fired soft coal. Approximately estimated, oil at five cents per gallon will give the same cost for evaporating 1,000 pounds of steam as coal at ten dollars per ton. Consequently, there are only a few limited districts in which oil firing may be financially attractive. Otherwise, oil would be ruthlessly wasted until the supply was entirely depleted.

A conservation program with some of the following features included would prove beneficial: Regulation of quality of coal shipped from mine; zoning of coal as an aid to economical transportation; better means of storage, which is urgently needed to flatten out the load curve at the mines; co-operation between the coal-consuming public and the Bureau of Mines; the appointment of a body of citizens advisory to the United States Bureau of Mines in the planning and development of a conservation program. The program should interest itself in the correct design of new power plants, etc., a broader and more comprehensive plan of education than before applied along conservation lines.

Charles E. Gorton, chairman of the American Uniform Boiler Law Society, reported that boilers built to the Code of the American Society of Mechanical Engineers were now admitted to all states and cities having boiler regulations with the exception of Massachusetts. He read a long list of universities and colleges that have adopted the Code as a text or reference book. Since his last report, Oregon, Arkansas, Indiana, Maryland and Utah have become Code states, which is very encouraging for a year when few of the legislatures were in session.

C. O. Myers, secretary-treasurer of the National Board of Boiler and Pressure Vessel Inspectors, told of the work of the board since its organization last December. It consists of the inspectors or other officials charged with the enforcement of regulations covering boilers and pressure vessels in cities and states that have adopted the A. S. M. E. Code. One of its functions is to make rulings on specific designs of boilers and appurtenances not covered by the Code and to bring about the uniformity of practice in such matters that would be impossible without co-operation between the inspectors in the various states that are represented.

On Monday evening W. C. Connelly, who has served the association as its president for four years, presented his annual address. He recommended a simplification of the method of war taxation, recalled his prediction of a year ago—which has been verified—of a large increase in volume of business, but foresees a slowing up for the next twelve months. This he regards as one of the best signs of returning sanity that we have had.

Prices are high because labor has demanded and has been receiving wages far beyond what it earned; because of the decrease in production, by strikes, of thousands of articles of daily use; because the hours of production have been reduced 10 or 15 per cent and the actual production per man hour 25 to 50 per cent.

The cure is "everybody at work six days every week and producing a fair day's output."

He referred to the steel, coal and railroad switchmen's strikes and urged that a decided stand be taken for the open-shop principle and for hearty co-operation with the United States Chamber of Commerce and with the National Association of Manufacturers. Continuing, he said:

Photo by Gravelle Pictorial News Service, Indianapolis

One of the complications involved in the enforcement of the Code in the case of boilers built in one state for use in another is the matter of providing for shop inspection during construction. In order that the certificate of the inspector at the shop where the boiler is made may be valid and satisfactory to the inspection department of a perhaps distant state in which the boiler is to be used, the local inspector must have proved his competency to the satisfaction of the departments of all the states or cities into which the boilers which he inspects may go. It is therefore suggested that all boiler inspectors operating under the departments represented be subjected to a uniform examination, and that, having qualified in this way, their certificates of inspection shall be universally accepted.

It is hoped to devise a system whereby the method of stamping and identification of boilers may be simplified, and the record of a boiler from its building to its final disposition be kept intact and easily accessible. A national convention of the Board will be held in the early future.

H. N. Covell reported as secretary-treasurer that the association numbered 78 active member companies, besides the associates, and was in a flourishing condition financially.

Monday afternoon was devoted to a golf tournament, in which a large proportion of the members took part.

This is not the time to make improvements or extensions, nor to stock up. Purchasing only of necessities by everyone will within a period of several months result in adjustment of prices to be more nearly normal.

Now is the time to reduce inventories to as low a point as is practicable. "A slowing up of business cannot but result in a reduction in prices by the independent producers of steel to those prices established and maintained by the United States Steel Corporation."

Reductions in prices lead to business failures—watch your credits. Standardized construction has been brought about through the Boiler Code of the A. S. M. E. Considerable progress has been made toward a uniform system of cost finding. It is hoped that this convention will arrive at certain standards regarding guarantees, terms of payment, etc. Standard sizes for all documents such as order forms, specifications, invoices, etc., were recommended. The address closed with acknowledgments to his associates and a plea for greater co-operation.

E. C. Fisher presented a report from a conference committee with the Stoker Manufacturers' Association to define terms in which the A. B. M. A. and the S. M. A. are interested. The following definitions were proposed and unanimously accepted:

For the purposes of the American Boiler Manufacturers and the Stoker Manufacturers associations the following definitions are adopted:

A BOILER is a metal vessel capable of withstanding pressure and serving the purpose of transmitting heat, usually produced by the combustion of fuel, to a liquid contained in the vessel.

In power-plant practice, boilers are usually divided into two classes, as follows:

(a) A FIRE-TUBE BOILER is so constructed that the products of combustion pass within tubes or their equivalent, these being surrounded by the liquid to be heated.

(b) A WATER-TUBE BOILER is so constructed that the liquid to be heated is contained within tubes or their equivalent, these being surrounded by the products of combustion.

A BOILER BAFFLE is a plate or partition placed in such relation to the tubes or their equivalent of a boiler as to cause the products of combustion to move in predetermined paths.

A FURNACE is a partially enclosed space in which heat is produced by fuel combustion.

A FURNACE ARCH is made of refractory materials forming the roof of a furnace or so located within a furnace as to aid combustion.

A GRATE is a metallic structure designed to support solid fuel and so made that air for combustion can pass through it to the fuel.

A TUYERE is a nozzzle constructed to direct air under pressure into a fuel bed.

A TUYERE BLOCK is a special form of grate containing a tuyère or tuyères.

A RETORT is a receptacle so constructed that solid fuel may pass through it and in which partial distillation of the fuel takes place.

A DEAD PLATE is an imperforate plate which supports fuel.

A DUMP PLATE is a movable plate, grate or combination of same for intermittently discharging refuse from a furnace.

A MECHANICAL STOKER is a device consisting of a mechanically operated mechanism for feeding solid fuel into a furnace combined with means for supporting the fuel and supplying air to same during combustion and for directing the deposit of refuse in a location from which it can be readily removed from the furnace.

AN OVERFEED STOKER is a mechanical stoker where fuel is fed onto grates at one end of same. Overfeed stokers are usually divided into three classes as follows:

(a) A FRONT-FEED INCLINED-GRATE STOKER is an overfeed stoker where fuel is fed from the front onto grates inclined downward toward the rear of the stoker.

(b) A DOUBLE-INCLINED SIDE-FEED STOKER is an overfeed stoker where fuel is fed from both sides onto grates inclined downward toward the center line of the stoker.

(c) A CHAIN OR TRAVELING GRATE STOKER is an overfeed stoker where fuel is fed to the stoker from the front onto a moving grate forming an endless chain.

AN UNDERFEED STOKER is a mechanical stoker having one or more retorts from which the fuel is fed from below the surface of the fuel bed.

DRAFT is a difference in pressure due to a difference in gas density which tends to cause a flow of gas from the region of higher pressure to that of lower pressure.

NATURAL DRAFT is a draft produced by a chimney.

INDUCED DRAFT is a draft produced by mechanical means located at some point between a furnace and the point where the products of combustion are discharged.

FORCED DRAFT is a draft produced by mechanical means whereby pressure above atmospheric pressure is maintained under a grate.

D. C. Alexander, Jr., president of the Quasi-Arc Weldtrode Co., Inc., presented a paper, illustrated by lantern slides, on "Electric Welding."

S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Co., discussed the Advantages of Co-operation between Boiler Manufacturers and Boiler Insurance Companies. He emphasized the many ways in which the boiler manufacturer and the insurance company can work with each other, or co-operate, and the interest of both is served. Insurance companies are frequently confronted with claims due to minor accidents. If the boiler maker when making repairs where an insurance company is involved would keep the cost of repairs due to the accident separate from any general repairs that might be made at the same time, it would be very advantageous to the insurance company as well as the insured, who is the boiler maker's patron. In this way the possibility of controversy is avoided. He also pointed out the value of the insurance company to the manufacturer in helping him keep up to the standard which he desires to maintain and in meeting the legal requirements for construction where boilers must be built to conform with boiler laws. The address concluded with the suggestion that the maximum limit, 55,000 lb., used in figuring pressures be changed to conform with the A. S. M. E. code requirements.

Tuesday morning was devoted to an executive session, the ethics and economics of boiler making occupying most of the time. In the afternoon there was a golf tournament and in the evening a banquet.

Wednesday forenoon the election was held resulting in the choice, without contest, of the following officers for the ensuing year: President, A. D. Schofield, of J. S. Schofield's Sons Co., Macon, Ga.; vice president, George S. Barnum, of the Bigelow Co., New Haven, Conn.; secretary-treasurer, H. N. Covell, of the Lidgerwood Manufacturing Co., Brooklyn, N. Y. Executive committee: W. C. Connelly, the D. Connelly Boiler Co., Cleveland, Ohio; C. V. Kellogg, the Kewanee Boiler Co., Chicago, Ill.; F. C. Burton, Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Co., Edge Moor, Del.; W. A. Drake, the Brownell Co., Dayton, Ohio; E. C. Fisher, the Wickes Boiler Co., Saginaw, Mich.; W. H. Mohr, John Mohr & Sons Co., Chicago, Ill.; W. S. Cameron, Frost Manufacturing Co., Galesburg, Ill.

E. R. Fish, representative of the Association on the A. S. M. E. Boiler Code Committee and in the American Uniform Boiler Law Society, discussed the use of welding in boiler construction and said that notwithstanding the excellent results displayed in the paper to which the association had listened, he thought that manufacturers should proceed with caution in the use of welding for portions under stress of vessels such as boilers the rupture of which meant the release of a large amount of energy. The cast metal of which the weld is composed is not well adapted to withstand the repeated stresses due to pressure and temperature changes incident to boiler practice, and while many specimens of welding exhibit excellent holding power on test, so much depends upon the operator that one is never sure how dependable the joint may be. The present A. S. M. E. Code inhibits the use of welding for parts under stress, but the subcommittee on welding is considering directions in which approved practice may be broadened with such precautions as will safeguard the user and the public. He spoke briefly, too, of the National Board of Inspectors, emphasized the importance that it is likely to assume in the system of inspecting and recording boilers and urged the support of the Association for it.

Resolutions were passed against the compulsory enforcement of the metric system; indorsing the principle of the open shop and condemning collective bargaining when it involves agents outside of the shop or restricts the liberties or activities of the individual workman; for the appointment of an industrial committee to investigate labor problems and bring about a better relation between employer and employee; for the disapproval of the bonus bill; of thanks to the Kewanee Boiler Co. for the entertainment furnished by the male quartet that they brought to the convention; of thanks to the members of the executive and other committees of the association for their services and to W. C. Connelly the retiring president. Mr. Connelly was presented with a handsome silver coffee service at the banquet.

The undertaking of the bricksetting by the boiler manufacturer was discussed, the general disposition being to do so only as an accommodation to the customer who wishes to avoid a multiplicity of contracts and divided responsibility. A committee was appointed to collect and codify the specifications of the member companies in this respect.

The Code Committee was asked to furnish a report on Standard Steam Outlets, including the use of studded pads instead of standard steam nozzles.

Questions relating to standard guarantees, and proper methods for estimating the cost of a job were referred to the commercial committee.

A committee was appointed to consider uniformity of terms used in connection with a boiler setting.

Mr. Connelly called attention to the importance of heating and ventilating boiler shops as a question which will soon be forced upon boiler manufacturers and suggested that attention be paid to it at a future meeting.

At noon the convention adjourned.

National District Heating Association

The eleventh annual convention of the National District Heating Association was held May 25-27 at the La Salle Hotel, Chicago. The problems of the central stations in operating steam- and hot-water heating systems as adjuncts to their electric business were discussed, and the opinion was freely expressed that such steam-heating departments could and should be profitable. A number of suggestions was made in the course of papers and discussions for making the heating branch of central stations more renumerative than formerly. President J. C. Hobbs, of Pittsburgh, delivered a comprehensive address on operating problems, in which he suggested more efficient methods of central heating-plant operation. Prof. J. B. Hoffman, Purdue University, suggested and outlined a course for the technical training of men in the heating profession. The relative advantages of steam and hot-water heating was the subject of a paper by R. V. Stureman, of the Stureman-Butterick Co., Springfield, Ill., and an analysis of heat losses from underground pipes was treated in a paper by Prof. J. R. Allen, of the Research Laboratory of the American Steam Heating and Ventilating Engineers, Pittsburgh, Pa.

In a discussion of Professor Allen's paper, Mr. Walker of Detroit brought out the necessity for establishment of standards on which to base the calculation of pipe-covering efficiency. Mr. Walker with several others emphasized the lack of any definite basis from which to make the calculations; consequently figures on the efficiency of steam-pipe covering as ordinarily given are misleading.

During the course of the discussion of this paper, Professor Allen stated that he was taking up with Michigan Agricultural College, the question of experiments to determine the conductivity of the ground. Whether these arrangements will be finally carried out or not he was unable to state. It was further pointed out by Professor Allen in the discussion that the basing of computations of heat loss in pipes buried in the ground on experiments made in still air were valueless, in that heat losses underground are by conduction while those in still air are due to convection. In the discussion of the subject the importance of drainage in preventing heat losses in underground pipes was emphasized.

The problem of separating the steam and electric parts of utilities was discussed in the report of the accounting committee. The officers elected for the ensuing year were: President, J. L. Hecht, Chicago; First Vice President, J. H. Walker, Detroit; Second Vice President, E. L. Wilder, Rochester, N. Y.; Third Vice President, W. G. Carlton, New York City; Secretary-Treasurer, D. L. Gaskill, Greenville, Ohio. In addition to these officers, J. C. Hobbs, Pittsburgh, Pa., Fred B. Orr, Chicago, and F. A. Tucker, Danville, Illinois, were elected to the executive committee.

Assistance in Cases of Coal Shortage

The Washington representative of the National Committee on gas and electric service is in daily touch with the Interstate Commerce Commission, presenting the individual cases reported by gas and electric light and power companies of shortage in the coal supply. Cases requiring action should be reported direct to the offices of the committee, at Room 950, Munsey Building, Washington, D. C., but action can be secured only where full information is given, including the amount of coal actually on hand and the rate of daily consumption, the name of the contractor or shipper, the location of the mines and the railway or railways over which delivery is made.

The Dissipation of Heat by Various Surfaces

In a paper by T. S. Taylor, presented at the spring meeting of the American Society of Mechanical Engineers, St. Louis, May, 1920, are given the results of some interesting experiments on the loss of heat from various surfaces. Noting that hot water in bright tin vessels cooled more rapidly than in similar vessels covered with thin sheet asbestos, experiments were undertaken which showed that tin pipes, such as furnace pipes, actually dissipate more heat when tightly covered with thin asbestos than when left bare. Another set of tests were made to obtain data on the influence on the heat dissipation, of air velocities over the hot surfaces. These latter experiments were made with special reference to the cooling of electrical apparatus by ventilation.

For the former tests tin cylinders 10 cm. (3.9 in.) in diameter and 50 cm. (19.7 in.) long, containing cylindrical electrical heaters, were constructed. The temperature inside each vessel was measured by a thermometer inserted in the side, and thermocouples were attached to the outer surface to measure the surface temperature. The vessels were placed horizontally in such positions in the room as to avoid unnecessary convection currents and the room temperature taken at points sufficiently distant from the vessels to be uninfluenced by them. The heat required to maintain various differences between inside and outside temperatures was computed from the electrical-energy input as shown by ammeter and voltmeter readings.

Experiments were made under the following surface conditions: Plain bright tin; tin covered tightly with 0.33 mm. (0.013 in.) sheet asbestos; tin covered loosely with three layers of 0.33 mm. asbestos; tin covered with three layers of air-cell asbestos; tin aluminum painted; and various dust-covered surfaces.

The results obtained show that over the temperature range covered in these tests the thin asbestos covering results in an average of 37 per cent more heat loss than is found with bare bright tin. Even when both are covered with dust the asbestos surface will lose 23 per cent more heat than the bare one. The effect of dust on the surface is to increase the loss from the bare tin and decrease the loss from the asbestos-covered surface. Three layers of the 0.33 mm. asbestos covering loosely applied will give practically the same loss as the bare tin, while three layers of air-cell asbestos will permit a loss of only 75 per cent of that from the uncovered pipe.

The results are contradictory to the commonly accepted theory that any covering of heat-insulating material will cause a reduction in the heat dissipated from a hot surface. In explanation the author states that the asbestos surface is three or four times as great as the tin surface so far as molecular dimensions are concerned. The loss being due chiefly to air contact, this increased surface offers a greater chance for heat to be liberated. Therefore the thickness of the covering must be such that its decreased conductivity will make up for the increased surface effect before any saving may be expected. By an approximate calculation based on surface-temperature measurements, the author concludes that 0.51 cm. (about 0.2 in.) is the thickness of tightly applied sheet asbestos which will just equal bare tin pipe in heat dissipation. Thicknesses below this will give greater, and above this, smaller heat losses.

To study the effect of air velocities on heat losses, a special heater was constructed to represent a typical end coil of a turbo-generator. An iron bar 1½ x 1½ x 24 in. was covered with a ⅛-in. layer of heater mica on which was wound a heater wire. On this was another layer of mica, and the whole apparatus was wrapped with the specified insulation material. Outside of this was a layer of fish paper, a layer of lead and a layer of sheet iron. Thermocouples were arranged to measure temperature inside and outside the insulating layer. The whole apparatus was placed in front of a blower outlet of such dimensions (2¼ x 2¼ x 24 in.) that the coil was completely within the air stream. Air velocities were measured by means of a pitot tube.

From the data obtained, curves were plotted from which the author deduces the following general conclusions:

The heat liberated per degree difference in inside and outside temperatures increases approximately uniformly with the velocity over the ranges indicated. The heat liberated per degree excess temperature is constant for all temperatures for any given constant air velocity, except in the case where the velocity is that due only to natural convection currents when this value varies.

Tests were run with the coil set at various angles of incidence with the air current. The curves plotted from the data of these tests indicated that the maximum amount of heat would be dissipated when the air current met the surface at an angle of about 42 degrees.

New Jersey N. A. S. E. Convention

The annual convention of National Association of Stationary Engineers was held in Phillipsburg, N. J., June 3-6. Hotel headquarters was at the Huntington, Easton, Pa., across the Deleware River from Phillipsburg. The mechanical exhibit opened on the third, the business session of the delegates on the fifth. The Mayor of Phillipsburg made an appealing address of welcome, which was responded to by Charles H. Bromley, of Newark No. 3 Association. National President John J. Calahan, First National President Henry Cozens, and William Reynolds, chairman Board of Trustees, followed.

The convention was given a real treat in the form of an address on Americanization by Captain J. W. Riddle, superintendent of Public Schools, Phillipsburg. This address was by far the best of its kind the writer, who has heard many, ever listened to. S. B. Redfield, engineer, Ingersoll-Rand Co., Phillipsburg, followed.

President Val. V. Secor opened the convention. In the course of his address, National President Calahan stated that New Jersey had passed Massachusetts, Ohio, Pennsylvania and Illinois in membership.

The new officers are: George Armitage, Atlantic City, president; Charles L. Johnson, Elizabeth, vice president; Samuel Clark, Jersey City, secretary; John Mycock, Trenton, treasurer; John Shuey, Perth Amboy, conductor; Fred Beecroft, doorkeeper. John J. Reddy, of Jersey City, was again chosen state deputy. The convention next year will be held in Jersey City.

At the close of the session on Sunday the delegation visited the huge works of the Ingersoll-Rand Co., where, after an inspection of the shops, the company served a most complete and relished dinner.

On June 1 a 500-kw. steam turbine exploded at the Phœnix Mills, Utica, N. Y. Buckets were thrown out, breaking the casing and knocking holes through the brick walls. The engineer was killed. The speed is given at 2,200 r.p.m.

New Publications

POROSITY AND VOLUME CHANGES OF FIREBRICKS

Technologic Paper No. 359, "Porosity and Volume Changes of Clay Firebricks at Furnace Temperatures," is now ready for distribution by the Bureau of Standards. This investigation is a study of some of the physical properties of clay firebricks by a comparison of their changes in porosity and volume, on heating to different temperatures, with the amount of contraction of the bricks under load at furnace temperatures, and with their so-called "melting points." It is found that the porosity and volume changes serve as a much more reliable indication of the ability of a clay firebrick to resist deformation under load at furnace temperatures than the "melting point." It is also shown that these porosity and volume changes serve in explaining the failure of firebricks in use, from such causes as insufficient burning in manufacture.

Personals

Warren D. Spangler, consulting industrial engineer, Marshall Building, Cleveland, Ohio, desires catalogs from manufacturers of steam and electric power appliances.

Frank L. Platt, formerly retained by the War Department as a specialist on Industrial Planning Projects, has become associated with the firm of Waldron & Van Winkle, of New York and Boston. Mr. Platt will be in the New York office at 37 Wall St.

W. C. Buell, Jr., formerly engineer of tests, and later chief engineer of Tate-Jones & Co., Inc., on June 1 became associated with the George J. Hagan Co., of Pittsburgh, furnace and combustion engineers, as chief engineer of the company's newly organized liquid fuel department.

Dr. Alphonse A. Adler, of the Polytechnic Institute of Brooklyn, after ten years of service as professor in charge of machine and power plant design, has resigned in order that he can give his undivided attention to his consulting practice in New York City in power and industrial plant engineering.

W. W. K. Sparrow, assistant chief engineer of the Chicago, Milwaukee & St. Paul Railway Co., has been appointed assistant to the president of that railroad. He will be in charge of valuation, adjustment of Federal accounts and other assigned duties. He was corporate chief engineer of the Milwaukee Ry. Co., during Federal control.

Society Affairs

The Washington Assembly of the American Association of Engineers was recently organized and a committee appointed to prepare the constitution and by-laws.

The Twin City Chapter of the American Association of Engineers has requested enlargement of the powers of the St. Paul city charter empowering the city council to determine salaries of city employees.

The Eastern Geographic Section of the Pennsylvania Electric Association will meet Friday, July 2, at the Adelphi Hotel, Philadelphia, Pa. Topics to be discussed will include "Power Factor and the Effect of Unbalanced Load on the System."

The American Water Works Association will hold its fortieth annual convention from June 21 to 25 at Montreal, Quebec, headquarters at the Windsor Hotel. Besides various important and interesting papers, a big feature of the convention will be the amusements arranged by the entertainment committee. These include dancing, concerts, golf, sightseeing trips, etc.

The American Association of Engineers, Nebraska Assembly, held its first annual meeting May 29 in Lincoln. The following officers were elected: President, W. R. McKeen, president Omaha Chapter, A. A. E.; first vice president, Prof. Clark E. Mickey, University of Nebraska; second vice president, Roy N. Toll, city commissioner, Omaha; treasurer, George W. Bates, city engineer, Lincoln, Neb.; secretary, Watson Townsend, assistant engineer, U. P. R.R., Omaha.

S. A. E. Annual Meeting Program—The summer meeting of the Society of Automotive Engineers is scheduled to take place from June 21 to 25 inclusive, at Ottawa Beach on Lake Michigan. In addition to the various sessions, including a Standards and Business Session, Fuel Session, Transportation Session, Farm Power Session and production Session, a wonderful program of amusements and recreation has been planned. On Thursday evening, June 24, a grand ball will be held, including a dancing contest. With the exception of Monday there will be dancing in the ballroom every evening. Over 200 prizes will be given in the sports program, which will be conducted on Tuesday, Wednesday and Thursday afternoons. Tennis, golf, baseball, trap-shooting, races, water sports and special sports will be staged.

Miscellaneous News

The Niagara Falls Power Company has declared a dividend of $1.75 per share on its preferred stock, payable June 30, 1920.

Mayor Hugh M. Caldwell of Seattle, Wash., has signed a city ordinance accepting the stipulations of the Government for the permit granting the use of certain lands in the Washington National Forest for the Skagit power-plant project.

A Certificate of Merit by the War Department for making prompt deliveries of stokers for Government plants and otherwise co-operating with the Construction Division of the Army during the recent war has been awarded the Detroit Stoker Co.

The Pacific Gas and Electric Company is planning to construct its third power unit in Shasta County. The new project will be on Pitt River, four miles down stream from where Fall River tumbles over into the Pitt. Fall River Mills is at the junction of Fall and Pitt Rivers. Two miles up Fall River from the town, a tunnel 10,500 ft. will be dug through Saddle Rock Mountain. Nearly all the water in the river will be turned through this tunnel. At the southern outlet the water will be 575 ft. above Pitt River, which, with Fall River, makes a long horseshoe bend. A pipe line 3,000 ft. long will deliver this water under 575 ft. pressure on the banks of Pitt River, where the third power house will be built. This unit will generate 68,000 hp., and is to be connected within a year.

Business Items

The Wheeler Condenser and Engineering Co., of Carteret, N. J., is completing three condensers for 20,000-kw. turbines for the Union Electric Light and Power Co., of St. Louis; one of 15,000-kw. for the Indianapolis Light and Heat Co., one of the same size for the Omaha Light & Power Co., and still another for the Wichita (Kan.) Light and Power Co., also one 10,000-kw. unit each for the Midwest Utilities Co. at Tulsa, the Tennessee Light and Power Co. at Memphis, and the Central Illinois Public Service Co. at Harrisburg, Ill.

Trade Catalogs

The Westinghouse Electric and Manufacturing Co. of Pittsburgh, Pa., has ready for distribution a 20-page catalog entitled "Watt-Hour Meters," which describes and illustrates its line of watt-hour meters. The descriptions cover operation, distinctive features, construction and application. A copy will be sent on request.

The Page Steel and Wire Co., Monessen, Pa., has ready for distribution a new 31-page catalog entitled "American Ingot Iron Wire." The booklet contains, in convenient form, data and tables pertaining to the properties of American Ingot Iron Wire, of interest to engineers, superintendents, purchasing agents, etc. A copy will be sent on request.

"Industrial Buildings at Matagorda" is the title of a folder distributed by the J. G. White Engineering Corporation, 43 Exchange Place, New York City. It gives information about, and illustrations of, the power plant, warehouse, machine shop, and model homes erected for the housing of workmen, at the sulphur plant of the Texas Gulf Sulphur Co., Matagorda, Texas.

"America's Greatest Dam," by William Benjamin West, is a new 64-page booklet describing in detail the Wilson Dam, which is being constructed at Muscle Shoals, Nitrate Plant No. 2, Alabama. The book is written for the layman as well as for the technically inclined and contains a supplement on "Our Water Power," which sets forth the hydropower possibilities of this country.

COAL PRICES

Prices of steam coals both anthracite and bituminous, f.o.b. mines, unless otherwise stated, are as follows:

ALANTIC SEABOARD

Anthracite—Coals supplying New York, Philadelphia and Boston:

	f.o.b. mines
Pea	$5.30@$5.75
Buckwheat	3.40@ 4.10
Rice	2.75@ 3.25
Barley	2.25@ 2.50
Boiler	2.50

Bituminous—Steam sizes supplying New York, Philadelphia and Boston:

	f.o.b. mines
Cambrias and Somersets, f.o.b. mines net ton	$7.25@$8.00
Clearfields, f.o.b. mines, net ton	6.75@ 8.25
Pocahontas } on cars Providence and	11.00@14.50
New River } Boston; gross ton	11.00@14.50

BUFFALO

Bituminous—f.o.b. mines:

Pittsburgh slack	$6.00@$8.00
Mine-run	6.00@ 8.00
Lump	6.00@ 8.00
Youghiogheny	6.00@ 8.00

CLEVELAND

Bituminous—f.o.b. mines:

No. 6 slack	$4.50@$6.00
No. 8 slack	4.50@ 6.00
No. 8—¾-in.	4.50@ 6.00
No. 6 mine-run	4.50@ 6.00
No. 8 mine-run	4.50@ 6.00
Pocahontas—Mine-run	4.50@ 6.00

ST. LOUIS

Bituminous—f.o b. mines:

	Williamson and Franklin Counties	Mt. Olive and Staunton	Standard
Mine-run	$3.00@4.00	$3.00@3.50	$4.50
Screenings	3.00@4.00	$3.00@3.50	5.00
Lump	3.00@4.00	3.00@3.50	5.00

Williamson-Franklin rate to St. Louis is $1.10; Other rates 95c.

CHICAGO

Bituminous—Prices f.o.b. mines as per circular of April 1 are as follows: Co. prices vary from 50c. to $1.25

		Freight rate Chicago
Illinois		
Southern Illinois		
Franklin, Saline and Williamson Counties		
	Mine-Run $3.00@$3.10	$1.55
	Screenings 2.60@ 2.75	1.55
Central Illinois		
Springfield District		
	Mine-Run $2.75@$3.00	$1.32
	Screenings 2.50@ 2.60	1.32
Northern Illinois		
	Mine-Run $3.50@$3.75	$1.24
	Screenings 3.00@ 3.25	1.24
Indiana		
Clinton and Linton		
Fourth Vein		
	Mine-Run $2.75@$2.90	$1.27
	Screenings 2.50@ 2.65	1.27
Knox County Field		
Fifth Vein		
	Mine-Run $2.75@$2.90	$1.37
	Screenings 2.50@ 2.60	1.37
Brazil Block	$4.25@$4.50	1.27

New Construction

PROPOSED WORK

Me., Portland—The Construction Division, War Dept., Wash., D. C., will receive bids until June 21 for generator houses, steel hangars and miscellaneous construction at the coast defenses here.

Mass., Andover—Guy Lowell, Archt., 12 West St., Boston, will soon award the contract for a 2 story, 100 x 200 ft. memorial building, including a steam heating system, for the Philips Andover Academy. About $250,000.

Mass., Boston—The Construction Division, War Dept., Wash., D. C., will receive bids until June 21 for generator houses, steel hangars and miscellaneous construction at the coast defenses here.

Mass., Chelsea—H. H. Atwood, Archt., 61 Alban St., Dorchester, will soon award the contract for a 2 story, 35 x 90 ft. power plant and laundry addition to present building at the Soldiers' Home here, for the Commonwealth of Massachusetts, Boston. Estimated cost, $125,000.

Conn., Bridgeport—The Amer. & British Mfg. Corp. is in the market for an air compressor of 300 cu.ft. capacity, to be 2 stage type, either belt or motor driven, developing at least 100 lb. air pressure and also a reservoir tank about 3 ft. in diameter and 8 ft. high.

Conn., Bridgeport—S. Z. Poli Co., 24 Church St., New Haven, will soon award the contract for two 221 x 223 ft. theatres on Main and Congress Sts., including steam heating systems. About $1,000,000.

N. Y., Brooklyn—The Bd. of Welfare received bids for repairs to boiler settings and new boiler fronts at the power house at the Kings County Hospital here, from the Acme Furnace Equipment Co., 39 Cortland St., $15,052; Frederick Page Contg. Co., 115 B'way, $18,200.

N. Y., Brooklyn—The Brooklyn Union Gas Co., 176 Remsen St., is in the market for 2 gas pumps and several generators for the station at 12th St. and Second Ave.

N. Y., Brooklyn—Charles L. Fraser, Archt. and Engr., 103 Park Ave., New York City, will soon award the contract for a 4 story department store including a steam heating system on B'way between Grove and Linden Sts., for the Buckley Newhall Co., 5th Ave. and 125th St., New York City. About $250,000.

N. Y., Buffalo—The Buffalo Wagon Works, 111 Carroll St., is in the market for one 5 hp., 500 d.c. motor.

N. Y., Buffalo—The Houde Eng. Corp., 1400 West Ave., is in the market for a small air compressor about 4 in. bore.

N. Y., Buffalo—Frank Lanahan & Sons, 174 Fulton St., is in the market for a 12 x 14 x 275 ft. air compressor with tank.

N. Y., Iona Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to improve the Naval Magazine power plant here. About $27,000.

N. Y., Jamestown—Lyman P. Hapgood, Supt. of Water and Lighting, plans to install at the Cassadago station, three 150 hp. water tube boilers with equipment, 2 steam driven centrifugal pumps normal capacity 5,000,000 per 24 hours, 2 steam air compressors, compound 2 stage, capable of delivering sufficient air under 80 lb. pressure to equal 160 hp., pumping engines, 2 motor driven volute centrifugal pumps, not to exceed 1,200 r.p.m., 440 volt, 60 cycle, 3 phase; 2 directly connected steam turbine generators to generate current at 440 volt, 60 cycle, 3 phase, capacity 378 turbine capacity 540 hp., 2 motor driven, 2 stage air compressors, which will furnish sufficient air at 80 lb. pressure to produce 160 hp.

N. Y., Long Island City—The Horizontal Hydraulic Hoist Co., 35 25th St., Milwaukee, Wis., plans to build a 1 story, 100 x 150 ft. service station.

N. Y., New York—The Auditorium Association, c/o Slee & Bryson, Archts. and Engrs. 154 Montague St., Brooklyn, is having plans prepared for a 4 story, 75 x 150 ft. club and office building including a steam heating system at 250 West 25th St. About $250,000.

N. Y., New York—The Construction Division, War Dept., Wash., D. C., will receive bids until June 21 for generator houses, steel hangars and miscellaneous construction at the coast defenses here and at Long Island Sound.

N. Y., New York—Keeler & Fernald, Archts., 203 West 13th St., will soon award the contract for an 8 story loft building including a steam heating system at 251 West 27th St., for the Herzig Mercantile Co.

N. Y., New York—The New York Bellevue and Allied Hospitals, 26th St. and 1st Ave., plans to construct a hospital addition including a steam heating system. About $800,000. McKim, Mead and White, 101 Park Ave., Archts.

N. Y., Oakfield—Genesee Light & Power Co. of Batavia has petitioned the Pub. Serv. Comn. for authority to issue $56,700 in preferred and $50,000 common stock to equip their plant here for the purpose of supplying additional power and lighting here and to extend the transmission lines to Byron, Darien and Alexander.

N. Y., Olean—The Bd. Educ., Union Free School Dist. 1, will soon award the contract for installing heating and ventilating equipment in school buildings No. 1, 5, 4 and 7. E. H. Keeney, clk. Phegley & Szekley, Merian Bldg., Cleveland, O., Engrs. Noted April 20.

N. J., Clinton—F. H. Bent, State Archt., 142 West State St., will receive bids until June 22 for a 3 story, 68 x 131 ft. maternity cottage and boiler plant. About $100,000.

N. J., Lakehurst—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until June 21 for the installation of power plant equipment. Estimated cost, $400,000.

Pa., Philadelphia—The Abrasive Co., Fraley and James Sts., plans to build a 1 story, 55 x 60 ft. power house including power equipment. Estimated cost, $25,000.

Pa., Philadelphia—The General Electric Co., Witherspoon Bldg., plans to build a plant, including a steam heating system, at 68-70th St. and Elmwood Ave. About $10,000,000.

Md., Baltimore—Samuel T. Williams, 223 North Calvert St., is in the market for a 3 phase, 25 cycle, 440 volt winding machine with motor, and a 250 hp. open type feed water heater.

Md., Laurel—The Maryland Motors Corp., 631 Munsey Bldg., Baltimore, will receive bids until August 1 for a 2 story, 30 x 50 ft. hydro-electric plant, to have a 600 kw., 3 phase, 60 cycle, a.c. capacity. Three 200 hp. steam turbines, two 500 hp. boilers and two 600 hp. waterwheels will be installed in same. Estimated cost, $120,000. T. B. Webster, 631 Munsey Bldg., Baltimore, Engr.

D. C., Washington—The Amer. Security & Trust Co., 15th St., plans to build a bank and office building including a steam heating system. About $1,000,000. York & Sawyer, 50 East 41st St., New York City, Archts. and Engrs.

D. C., Washington—The General Purchasing Officer of the Panama Canal will receive bids until June 18 for furnishing 20 upright, extra heavy, galvanized, riveted boilers, etc.

Va., Langley—The Construction Division, War Dept., Wash., D. C., will receive bids about June 20 for several buildings including a power house, etc., here. Cost, over $500,000.

Va., Richmond—The Odd Fellows Lodge plans to construct a temple including a steam heating system. Herts & Robertson, 331 Madison Ave., New York City, Archts. and Engrs. About $600,000.

S. C., Hartsville—The city plans to construct a sewerage pumping plant. About $15,000. C. C. Wilson, Columbia, Consult. Engr.

S. C., Paris Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until June 21 for power plant improvements. Noted June 1.

Ala., Gadsden—The Alabama Power Co. plans to build a transmission line from here to Lindale, Ga., a distance of 52 miles and deliver hydro-electric power to the substation there.

Ala., Muscle Shoals—The Constructing Quartermaster, U. S. Nitrate Plant No. 2,

will receive bids until June 21 for a transmission line between plants 1 and 2, approximately a distance of 4 miles.

O., Cleveland — The Brandt Co., Sheriff St. Market, plans to build a 6 story cold storage warehouse including a refrigeration system. About $300,000.

O., Cleveland — The Parish & Bingham Co., West 106th St. and Madison Ave., is having plans prepared for a 1 story, 30 x 55 ft. boiler plant at 10600 Madison Ave. Two 500 hp. boilers with stokers will be installed in same. Estimated cost, $100,000. Ernest McGeorge, 1900 Euclid Ave., Archt. and Engr.

O., Cleveland—William Taylor Son & Co., Euclid Ave., is having plans prepared for a 10 story, 69 x 200 ft. department store addition including a steam heating system at 614 Euclid Ave. About $500,000. D. H. Burnham & Co., 209 South LaSalle St., Chicago, Archt.

Ind., Evansville—The Indiana Atomized Fuel Co. plans to build a 1 story, 80 x 100-ft., 350 to 400 hp. electric driven plant to reduce coal to an atomized state. Estimated cost, from $125,000 to $150,000. B. U. Cain, Secy.

Ind., Indianapolis — The city plans an election in June to vote on $650,000 to construct a power plant at the Arsenal Technical high school.

Mich., Detroit — Louis Kamper, Archt., 749 Book Bldg., will receive bids until June 21 for a 10 story, 53 x 141 ft. office and loft building on Woodward Ave., including steam heating equipment, for Hugo Scherer. About $1,000,000. Noted April 20.

Mich., Detroit — The Manufacturers Mutual Insurance Co., 484 East Jefferson Ave., is having plans prepared for a 4 story, 45 x 150 ft. hospital and office building including a steam heating system on East Jefferson Ave. About $300,000. Stratton Snyder & M. R. Burrowes, Union Trust Bldg., Archts.

Mich., Grand Rapids—St. Mary's Catholic Congregation, 423 1st St., N.W., is having plans prepared for the construction of a 1 story central heating plant. E. Brielmaier & Sons Co., University Bldg., Milwaukee, Wis., Archt. and Engr.

Ill., Chicago — Albert L. Appleton and Associates, c/o Walter W. Alshlager, Archt., 111 West Washington St., are having plans prepared for a 21 story, 110 x 150 ft. hotel on Chicago and Michigan Aves., including a steam heating system. About $4,000,000.

Ill., Chicago—Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, Wis., are receiving bids for a 750 hp. pocket valve uniflow engine and a 500 kw. generator, also a 195 ft. stack, for the Illinois Malleable Iron Co., 1801 Diversey Blvd.

Ill., Chicago—The Chicago, Milwaukee & St. Paul Ry. Co., Office of the Purchasing Agent, is in the market for 1 locomotive hoist consisting of six 50-ton jacks fitted with a General Electric 50 hp. motor, one 5 hp. motor with starting box and switches for running hammer, one 10 hp. motor, speed variable from 550 to 1,100 r.p.m. for running boring mill. All electric equipment will be 220 volt, d.c.

Wis., Eau Claire—The Industrial Constr. Co., 3 South Barstow St., is in the market for 1 link belt conveyor.

Wis., Milwaukee — Cahill & Douglas, Engrs., 217 West Water St., will soon award the contract for the furnishing two 300 hp. boilers for Geuder, Paeschke & Frey, St. Paul Ave. and 15th St. Noted March 3.

Wis., New London — The Little Wolf Power Co., has obtained permission to construct and operate a dam on the Little Wolf River in Waupaca County, near here.

Wis., Sheboygan—The city will soon receive bids for a 4 story, 150 x 250 ft. high school including a steam heating system, on Jefferson and 9th Sts. About $750,000. Childs & Smith, 64 East Van Buren St., Chicago, Archts.

Wis., Wauwatosa — The Milwaukee Co. Bd. of Administrators, Milwaukee, will soon award the contract for intercepting sewers, pumping station and force main. Two 250 g.p.m. motor driven centrifugal sewage pumps will be installed in same. W. G. Kirchoffer, 31 Vroman Bldg., Madison, Wis., Engr.

Minn., Coleraine—A. King, Clk., will receive bids until July 15 for a 2 story, 200 x 200 ft. high school including a steam heating system for the Bd. Educ. Estimated cost, $350,000. W. T. Bray, 616 Torrey Bldg., Duluth, Archt. and Engr.

Minn., Duluth — The Great Northern Power Co. of Duluth plans to build a dam across Boulder Lake, for the purpose of developing 50,000 hp. in order to supply additional electric power to this town and towns on the Minnesota iron ranges.

Minn., Duluth—The Rev. J. T. McNicholas, 211 West 4th St., will receive bids until June 29 for a 3 story, 100 x 150 ft. grade school including a steam heating and mechanical ventilating system, on 28th Ave. East, and 4th St. About $250,000. Maginnis & Walsh, 100 Boylston St., New York City, Archts. and Engrs.

Minn., Hibbing—The town rejected all bids for a 2 story, 149 x 284 ft. recreation building on 1st Ave. and Jackson St. Halstead & Sullivan, Palladio Bldg., Duluth, Archts. and Engrs. Work will be readvertised. Noted May 10.

Minn., Minneapolis—The State University will soon receive bids for a 3 story, 95 x 160 ft. music building including a steam heating system. C. L. Pillsbury Co., 805 Metropolitan Bank Bldg., Engr. C. H. Johnston, 715 Capital Bank Bldg., St. Paul, Archt. About $500,000.

S. D., Sioux Falls—Symms-Brownell Mfg. Co. is in the market for one 28 to 34 x 12 to 14 in. milling machine and one 150 lb. drive air compressor (used).

Mo., St. Louis—The city will receive bids until June 29 for an engine house to have a 200 kw. capacity, and for the installation of one 220 hp. horizontal single direct connected side crank engine to be connected to a 200 kw. generator now in place, at the City Sanitarium Pumping Station, here. E. E. Wall, City Hall, Water Comr. Estimated cost, $15,000. Noted May 25.

Tex., Port Arthur—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until June 25 for furnishing and installing a heating boiler in the United States Post Office and Custom House, here.

Okla., Madill—The City Clerk will receive bids until July 1 for a 1 story, 30 x 40 ft. building, distribution system for water main, dam and a 150,000 gal. steel tank. Pumping equipment consists of two 500 S.P.M. triplex pumps, each driven by 75 B.H.P. fuel oil engine. Johnson & Brenham, Firestone Bldg., Kansas City, Mo., Engrs.

Ariz., Holbrook—The city plans an election to vote on $100,000 bonds to construct a water system, consisting of wells, pumping plant and distribution system. Olmsted & Gillilen, Hollingsworth Bldg., Engrs.

Wash., Puget Sound—The Construction Division, War Dept., Wash., D. C., will receive bids until June 21 for steel hangars, generator houses and miscellaneous construction at the coast defenses here.

Cal., Glendale—The Glendale Sanitarium engaged G. B. Larimer Baker, Detwiler Bldg., Los Angeles, to prepare plans for a central heating plant in connection with the proposed group of hospital buildings on B'way and Jackson St.

Cal., San Francisco — The Construction Division, War Dept., Wash., D. C., will receive bids until June 21 for steel hangars, generator houses and miscellaneous construction at the coast defenses here.

Que., Buckingham — The Town Council has appropriated $75,000 for 550 hp. electric power development of Aqueduct Ave. and is in the market for equipment.

Ont., Toronto — The Provincial Power Schemes will cost over $17,000,000, according to the supplementary estimate submitted to the Legislature. The great proportion of this, $10,500,000, is on the big development at Chippawa and Queenston; for the Niagara system, $1,250,000; Severn system, $50,000; Eugenia and Saugeen systems, $475,000; Muskoka system, $40,000; Port Arthur and Thunder Bay, or Superior systems, $2,500,000; Wasdell system, $90,000; St. Lawence system, $500,000; Rideau system, $250,000; Central Ontario system, $750,000; Nipissing system, $175,000; expenditures on account of province, $177,000; miscellaneous, $500,000.

B. C., Vancouver—The British Columbia Paramount Theatres Ltd., 963 Granville St., plans to build a 4 story, 120 x 120 ft. moving picture theatre on Seymour St., including a heating system. T. Lamb, 644 8th Ave., New York City, Archt.

B. C., Vancouver—The city plans to establish a hydro-electric plant at Heton Lake, capable of generating 175,000 hp. Estimatd cost, $12,000,000.

CONTRACTS AWARDED

Mass., Boston—The Suffolk Law School, 45 Mt. Vernon St., will build an 8 story, 87 x 110 ft. law school on Mt. Vernon St., including a steam heating system. About $300,000. Work will be done by day labor.

Mass., Cambridge—The Massachusetts Institute of Technology, Boylston St., Boston, has awarded the contract for the construction of a 4 story, 60 x 180 ft. college on Massachusetts Ave., to the General Building Co., 522 Harrison Ave., Boston. A steam heating system will be installed in same. Total estimated cost, $600,000.

Mass., Fall River — The Laurel Lake Mills, 484 Globe St., has awarded the contract for a 1 story, 40 x 52 ft. transformer station to Beattie & Cornell, 33 North Quarry St., at $25,000.

Conn., Manchester—The Mutual Heating Corp. has awarded the contract for a 1 story heating plant on Main St. to the Flynt Bldg. & Constr. Co., Palmer, Mass. at $50,000.

N. Y., Brooklyn—The Pub. Market of Flatbush, 1210 Flatbush Ave., has awarded the contract for the construction of a public market on Flatbush Ave., Duryea Pl. and East 22nd St., to Richard Von Lehn Sons, 2701 Ave. G. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., Brooklyn — Steven Ranson, 401 West St., New York City, has awarded the contract for a 1 story, 150 x 200 ft. machine shop and transformer station at 518 Hamilton St., including a steam heating system, to Wharton Green, 37 West 39th St., New York City, at $250,000.

N. Y., Rocky Point—The Radio Corp., Woolworth Bldg., New York City, has awarded the contract for a wireless station consisting of several buildings including a power house, to the J. G. White Eng. Co., 43 Exch. Pl., New York City. About $10,000,000. Noted June 8.

N. Y., Yonkers—The Yonkers Electric Light & Power Co. has awarded the contract for a 2 story, 100 x 225 ft. transformer station on Columbus Pl., to the Joseph Canepi Contg. Corp., Inc., 604 South B'way. About $200,000.

Pa., Philadelphia—L. H. Gilmer Co., Cottman and Keystone Sts., has awarded the contract for a 3 story, 95 x 150 ft. power house and warehouse, including a steam heating system, to W. D. Lukins, 432 West Walnut St., North Wales, at $200,000.

Pa., Philadelphia—The Philadelphia Electric Co., 10th and Chestnut Sts., has awarded the contract for a sub-station at 52-54 North 6th St., to John R. Wiggins Co., Otis Bldg., at $137,500.

Md., Baltimore — The City Council has awarded the contract of a 3 story, 63 x 121 ft. school including a saeam heating system, to the Standard Constr. Co., 1713 Sansom St., Philadelphia, at $400,000.

Tex., Fort Worth—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has awarded the contract for the installation of deep well pumping equipment, to the Layne & Bowler Co., Rand Bldg., Memphis, at $23,300. Noted April 27.

Cal., Long Beach—The city has awarded the contract for a sewerage pumping plant with pumps, motors, flush tanks, etc., to John Cummings, 1200 Washington Bldg., Los Angeles, at $44,649. Noted June 8.

Cal., Los Angeles—The Oil Mining Equipment Co., 2026 Santa Fe Ave., will build a group of factory buildings, including an 80 x 547 ft. main factory with a 60 x 150 ft. wing, boiler house, etc. Motors, etc., will be installed in same. Work will be done by day labor.

Cal., Santa Rosa—The Natl. Ice & Cold Storage Co., Postal Telegraph Bldg., San Francisco, has awarded the contract for a 1 story cold storage building addition, to A. M. Hildebrandt, at $100,000.